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MARINE ENGINEERING

INDEX TO VOLUME XXV

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Fig. 1.—Pier Shed, Showing the Many Kinds of Freight to Be Handled

How Electricity Helps Solve the Package Freight Handling Problem

BY F. T. SMITH*

THERE is in every port, and especially New York, a great industry employing many thousands of men which has been carried on in almost the same manner for many years. Wherever terminals exist and ships discharge and load their cargoes of freight, the work is done largely by hand and at constantly increasing cost. Other industries of all kinds with foresight have adopted efficient automatic machinery and electricity as the motive power, with good profit and increasing production to the enterprising company making such advancement.

Freight is handled today at a great many of our seaport terminals in many respects similarly to the methods used several hundred years ago. In many places production and freight shipped have increased at least 100 percent. During the past twenty-five years railroad traffic has increased over four and one-half times as fast as the population. Due to the fact that very little improvement has been made either in rebuilding or using modern methods of construction or by installing mechanical methods of handling, also to lack of cars, fuel shortage and increased cost of labor, and very largely to the ever-increasing flow of package freight to the terminals, this point, the junction of rail and sea, has become the little neck of the hour glass.

The ultimate customer pays approximately one-third of the amount of his goods for transportation in one form or another. An analysis of transportation charges based on the average haul shows that about 50 percent of the freight charge is due to the high cost of handling in terminals. The average cost per ton mile for hauling package freight over 250 miles, the ordinary length of freight haul on railroads, is three mills, or a total cost to the customer for 250 miles per ton of $0.75.

Let us compare this with results obtained at the terminals.

The average shipment goes through at least two terminals, and often one or more transfer terminals as well. The different classes of freight and constantly varying

* Power and Mining Department of the General Electric Company.

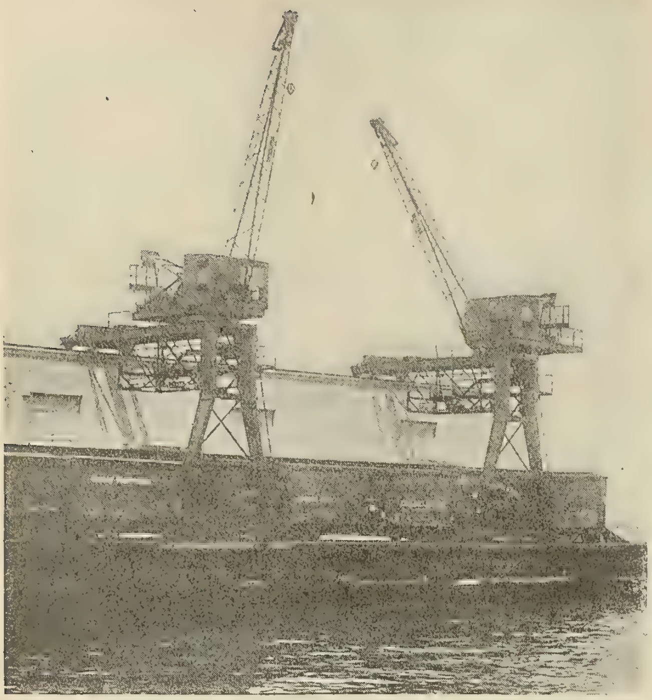


Fig. 2.—Semi-Portal Cranes and Double-Deck Pier

conditions make the cost per ton for handling hard to determine, but from available figures a safe average would be about $0.40 per ton per terminal, not including interest, depreciation and fixed charges on the terminal.

In the two terminals the cost of handling will be $0.80, or approximately 50 percent of the total cost of moving the ton of freight from the first delivery at one freight house to its departure from the terminal. More marked is the contrast at sea, for most authorities agree that ocean traffic costs only from one-sixth to one-tenth that of rail haulage.

New Electrical Devices Being Developed

No great systems for completely handling miscellaneous package freight have been developed, but the many electrically operated devices which are used as an aid are gradually developing themselves into a more complete system. Manufacturers of freight handling machinery are organizing in order that new apparatus may be developed, the present type used to best advantage and to promote a closer co-operation between the manufacturer and user. Recently, however, considerable attention has been given the package freight handling field. An example of this is shown in the piers and warehouses and seaport terminals built by the United States Quartermaster's Corps, and which are equipped with modern devices for saving labor in handling package freight.

The big problem, then, is to reduce the cost and time for handling at our terminals; to devise new ingenious machines and methods, and to make more economical and practical use of apparatus available for doing this work quicker and cheaper; to make labor better satisfied, and to reduce to a minimum the "turn around" of a ship in port and limit the possibilities of demurrage charges on railroad cars.

Electricity will play an important part in solving this problem. Central station electric power is available in all port cities and is sufficiently reliable to meet the requirements demanded of it by dock and terminal machinery. One type of machinery will not fit all conditions, due to a variety of freight and local conditions. Let us consider, however, the apparatus that is applicable to this work and how it may be used to advantage.

Cranes to Play Important Part in Future

Bridge cranes are so little used in package freight they will not be considered. Gantry cranes are common in railroad yards for serving gondola and flat cars, drays and temporary storage piles. A common span is 50 feet and the capacity runs from 25 to 100 tons. On the larger sizes there are usually four motors used, that is, main hoist, auxiliary hoist, bridge motion and trolley motion. They are equipped with alternating current (wound rotor motors) or direct current (series wound). Drum controllers are used in both cases.

Half-gantry, semi-portal or whirler cranes of 3 to 5 tons capacity span one and preferably two railroad tracks and are very serviceable for loading or discharging cargo from ships. One leg of the gantry runs on a track, while the other end of the crane travels along the edge of the pier shed.

The carriage with its whirler top permits the load to be taken from the hold of ship, swung and dropped into a car or at the side door of the pier shed. A modification of this would be the use of a straight track and carriage running out over the ship. This might be faster than the whirler type.

Locomotive cranes have the particular advantage of being ready at a moment's notice day or night. The number of motors required varies from one to five as a maximum. The power is obtained by means of a wooden-covered third rail alongside the track on which the crane is to work.

For cranes of any type where the hoisting speed is as high as 300 feet per minute, direct current is much the better proposition from the standpoint of operation on the machinery and life of the apparatus. However, for rope speeds of 150 or 200 feet per minute a very satisfactory alternating current arrangement using the solenoid load brake can be used. It is, however, somewhat more complicated to transmit three-phase current to an overhead structure by means of trolley wires than it is direct current.

Fixed and Portable Dock Hoists

It is interesting to note that a number of electric winches are being installed at several of the seaport terminals. A relatively small number of portable dock hoists rather than a large number of fixed ones has many advantages. They are made in single and double drum types with gypsy

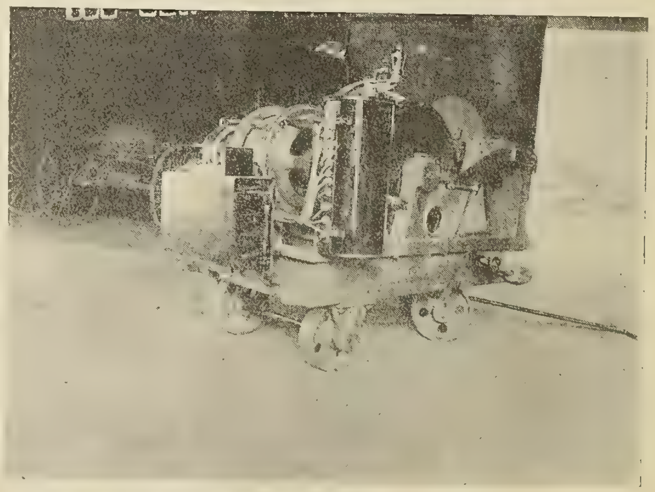


Fig. 3.—Portable Dock Winch with A. C. Motor and Controller

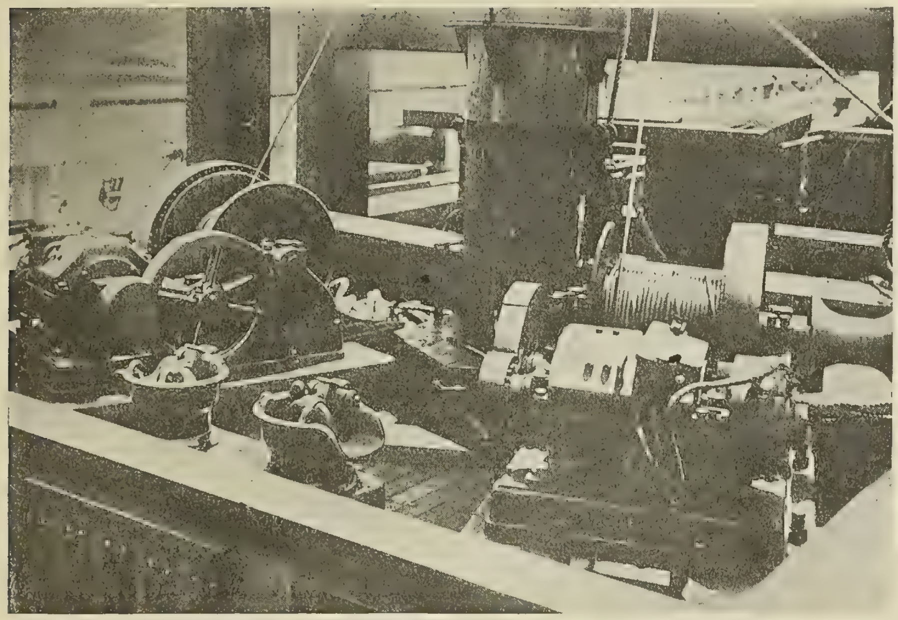


Fig. 4.—Electrically Operated Cargo Winch

heads and one or two motor drives. The winches are of about 2,500 pounds capacity and with a rope speed of 225 feet per minute and having either a 15-horsepower to 25-horsepower alternating current or direct current motor with solenoid brake or friction clutch and foot brake.

The control may consist of drum type controllers mounted on the machine or the magnetic control where the panel is mounted on the machine and the master controller is carried by the operator. The portable master controller when used with electric fixed or portable dock winches or with electric ship winches gives the operator a range of 100 feet radius or more if necessary and gives perfect control of both drums and the advantages of always having the load being hoisted or lowered in sight and insures quicker loading and unloading.

Briefly stated, the plan on which piers are being equipped is one of the following:

First, a sufficient number of portable two-motor, two-drum winches, with a double portable master controller strapped to the operator, who controls all movements from the ship's decks, are installed. The portable master is equipped with a broomstick support, which eliminates considerable strain from the operator in supporting the controller.

Second, a sufficient number of portable single-drum, single-motor winches, each controlled by a portable controller, is installed on the wharves.

At times when it is desired to use a single winch it may be controlled by a single portable master controller. The change from double portable master to single portable master can be easily and quickly made by means of transferring electric cables and plug connection boards.

In the near future electricity will be used more and more for electric winches for cargo handling on these cargo ships.

Of the many advantages of the electric ships' cargo winches over the steam winch, a few may be noted as follows: Clearer decks, greater ease and convenience of operation, greater certainty and dispatch in handling, no trouble from freezing up in cold weather.

The possibilities of the electrical industrial truck or "electric stevedore" have greatly increased since its introduction into the freight handling field. Trucks are usually rated at 2 tons capacity and work to best advantage on packages that can be readily handled by one or two men. They are tireless freight movers and the proper use of each type depends, of course, on lengths of haul, class of commodity, etc. Roughly, about half a mile out and return is the most economical distance per haul to operate an electric truck. When properly applied, they are able to cut the cost of moving freight to a marked degree. The motor used is enclosed, series wound, with a high starting torque, low current consumption and a very large overload capacity and designed to give the best results with the lowest possible drag on the batteries. The industrial truck is rugged and reliable in construction, simple in operation, and the flexibility of its movements gives it a big advantage over the machine limited to tracks. Of the many types, the following have been used with gratifying success in many places.

The load carrying type, where freight and material are carried on the platform of the truck, is especially adapted to work where trucks must be driven, loaded and unloaded by the same man, or wherever material is to be moved between widely separated locations in such quantities that it would not pay to have gangs of men to load and unload them. The load carrying truck serves best when hauling is restricted to narrow aisles and loading platforms, and where a destination is on a thickly congested floor where speed is of greater importance than tonnage.

INDUSTRIAL TRUCKS AND TRACTORS

The drop frame type is best adapted to carry heavy packages and pieces from 150 to 200 pounds, such as barrels, bales, heavy crates, etc. The greater the weight of separate pieces to be loaded, the lower the platform should be. It has been repeatedly demonstrated that after piling to a certain height it is false economy to require lifts that waste men's energy. As a rule, packages and pieces weighing 150 to 200 pounds can seldom be lifted higher than the knee; 75 to 100 pounds waist high, and

Fig. 5.—Load-Carrying Type of Truck Best Adapted to Narrow and Congested Aisles and for Use Between Scattered Locations

Fig. 6.—Elevating Platform Type Truck Having a Movable Platform the Height of Which Is Regulated to the Kind and Size of Load

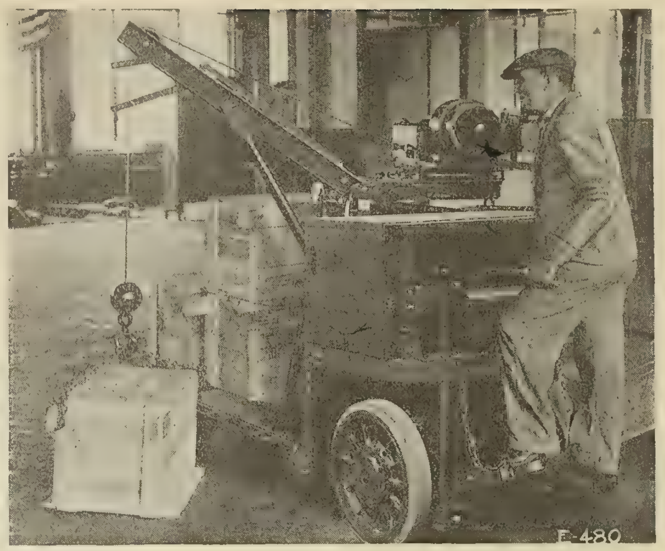


Fig. 8.—Crane Installed on Load-Carrying or Drop Frame Type Truck

25 to 35 pounds shoulder high. The heights are being decreased year by year.

The elevating platform type, similar to the drop frame type, has a movable platform which can be raised or lowered by a separate electric motor. These trucks are used for picking up, carrying and depositing loaded or empty skids or wooden platforms which can then be carried from place to place at the will of the operator. This method of freight handling is very effective, and surprising results have been obtained. The material placed on the skid or wooden platform is ready to be moved at a moment's notice; it can be vertically piled, by use of the electric piler described in a later paragraph, thus saving time and extra handling.

The baggage type is similar to the load carrying truck, or a combination of the load and drop frame types. This type is best adapted to carrying bags, trunks and mail pouches.

The crane type has an electrically operated crane of 1,000 to 4,000 pounds capacity, mounted temporarily or permanently on the load carrying or drop frame type. This type is especially adapted to handling heavy weights when the truck must move but short distances.

Another of similar type is the battery truck crane, which is larger and heavier and has a higher boom and longer outreach. This type has many applications in railroad freight terminals and piers and warehouses at marine terminals.

Tractors and Trailers Used to Advantage

The tractor truck is an economical self-contained power unit with a heavy draw-bar pull which carries no load, but pushes or pulls its load on trailer trucks. These trailer trucks are furnished with ball bearing front caster wheels which cause the trailers to follow very closely the tractor and give almost perfect tracking.

The tractor and trailer should have an important place in the modern terminal, the possibility of using three strings of trailers—one at the pile, one at the ship's side and one on the move—means less time lost and more material moved. It works to advantage where goods must be sorted in small unit loads and can be collected at one spot, then coupled in trains to be delivered to a single point or distributed. They will pull a trailing load of 50 pounds per pound of draw-bar pull and trailing loads of from 7,000 to 20,000 pounds, maintaining a speed of 4 to 5 miles per hour. A man with a hand truck, mule work, maintains a speed of less than 2 miles per hour with a load of 500 to 700 pounds. The saving in man power is evident.

Several successful installations of this method of freight handling have been made at railroad transfer stations.

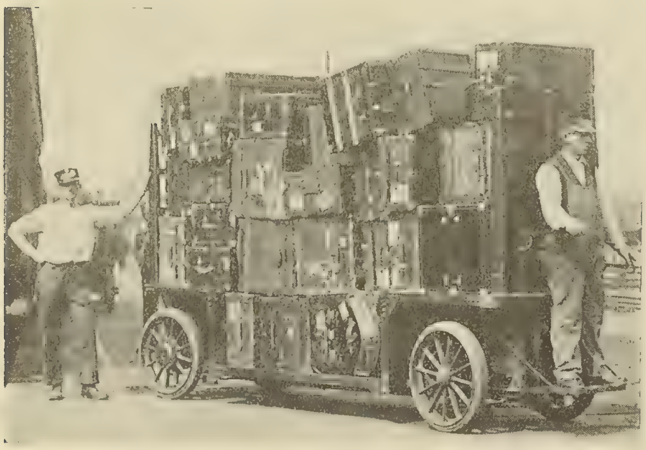


Fig. 7.—Bags, Trunks and Mail Pouches Are Easily Handled by the Baggage Type Truck

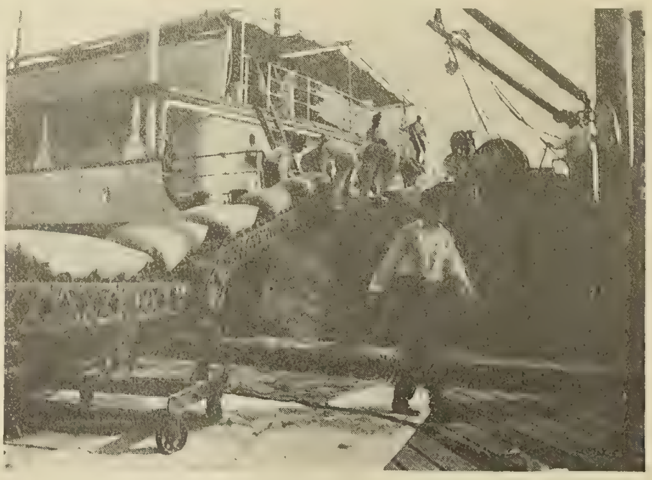


Fig. 9.—Discharging Coffee by Portable Conveyor from Ship to Wharf Shed, a Distance of 100 Feet

Fig. 10.—Tractor Trains in Various Combinations Have a Hauling Capacity of from 7,000 to 20,000 Pounds

Batteries and Battery Charging

The batteries may be either the lead Exide Iron Clad or the Edison, either one of which is in common use. The general characteristics of the two types are similar, but differ widely in specific points. Each has advantages that best adapt it to a particular installation.

Direct current is used for charging. If direct current is the supply it is furnished at the right voltage, either through a battery charging resistor or by a two-unit balancer set. If the source of supply is alternating current the mercury arc rectifier, motor generator set or rotary converter may be used to convert the alternating to direct.

The charging station should be so located that a truck or tractor will never have to travel more than 1,000 or 1,500 feet from the center of the area in which it operates to the place where it is to be charged.

Fig. 11.—Baltimore and Ohio Freight Pier No. 11, Philadelphia, Pa.

PORTABLE CONVEYORS AND PILING AND TIERING MACHINES

Sectionalized portable conveyors are used to great advantage for handling large quantities of packages of uniform size, small enough for two men to handle (200 to 400 pounds) at a capacity of about one ton per minute. Power consumption is very low and the machines are not expensive to install. The actuating motor may be a compound wound direct current or a squirrel cage alternating current 2-horsepower to 5-horsepower, totally enclosed or with some kind of suitable protection against moisture and dirt. Conveyors are usually furnished in 30-foot sections, but can be made shorter or longer to suit conditions. If considerably longer, several of the 30-foot sections with a motor every 30 to 50 feet may be used.

> "It is a surprising fact that it costs more to load a box of canned goods on a car in Chicago than it does to carry it from Chicago to New York. It costs more to transfer a barrel of flour over the wharf to a ship in New York than to carry it by ship from New York to Liverpool. Little remains to be done in reducing the actual cost of hauling freight, as rolling stock, roadbeds, vessels and harbors have been developed or are being developed to such a high state of efficiency that any further reduction in cost at this point would be of fractional nature."
>
> —F. T. SMITH.

Piling and tiering machines are motor-driven conveyors capable of working at an angle up to 60 degrees. Where they can be set up and used for two or three hours steadily, each having a capacity of one ton per minute, a saving of about 75 percent in expense over hand piling and unloading may be expected.

Vertical piling and stacking machines are useful for stacking bales of cotton, hogsheads of tobacco, bales of cloth and other large packages weighing around 400 to 500 pounds and capable of standing alone on a pile three or four tiers high. They can pile to ceiling capacity and readily handle packages that do not lend themselves to slings or that are fragile. The platform can be adjusted to the height of an industrial load carrying truck or the trailing trucks of a tractor making loading or unloading easy. It is used very efficiently in connection with the elevating platform truck and the loading skids or platforms. The uprights are jointed, which permits stowing and going through the doors. An automatic overtravel device brings the platform to a stop before reaching the extreme top or bottom. The motor, either alternating current or direct current, gives a hoisting speed of 30 to 45 feet per minute. The weight of this type is not great, and, being mounted on ball-bearing wheels, no hardship is involved in the frequent moves required to suit the growing or shrinking pile.

Occupying important places in the modern terminal could be mentioned the following: Escalators, telphers, industrial railways, cableways and elevators. These are all electrically operated and controlled. The elevator is a powerful freight mover, being used in buildings of more than one-story in height. These elevators in most cases are designed in sizes to conveniently carry several loaded industrial trucks or trailers.

Proper lighting of piers, freight houses and warehouses should receive special attention, especially where many men are busily engaged in handling heavy material under the pressure of the traffic of today. An average illumination of 0.15 to 0.25 watts per square foot is recommended. In warehouses the intensity of illumination, of course, should be greatest near the doors and along the main aisles. Plenty of light discourages pilfering, and light well distributed is necessary for the safety of the men and the quick and careful dispatch of freight.

Terminals and up-to-date piers are well protected by motor-driven fire pumps with reliable automatic control.

The following results may be expected from the adoption of electrical machinery:

Decreased cost of handling per ton.
Increased terminal capacity.
Increased storage capacity.
Increased handling capacity in the terminals.
Decrease in the length of time in handling.
Increased prestige of the port terminal as the outcome of these results.

Electrically operated mechanical devices of many designs for the quick, easy and efficient handling of package freight are on the market, and many others are being developed. Over seventy manufacturers are building apparatus of this kind.

Electricity is at hand and makes work easy. The central station power salesman is ready to make recommendations. The engineer has many improvements to offer from his wide experience and is ready to offer his services, with many valuable suggestions.

A closer association and co-operation of those most vitally interested, the aid of literature showing the great advantages and results gained by new developments and improvements, a more extended use of new appliances, and the use of the old, yet always new, electric power, will be the big factors in solving the freight handling problem.

Wage Scale on Shipping Board Vessels

A SURVEY of the wage scale in force on Shipping Board vessels has been compiled by R. C. McKenzie, connected with the accounting department of the division of operations of the Shipping Board. In this work the basis of compilation has been the exact amount of money paid out by the operators to the crews composing the deck, engine room and steward's departments. The exact figures for vessels of various classes are as follows:

Name	Class	Deadw't Tonnage	Number of Crew	Wages	Meals
Nansemond ...	A	15,000	162	$503.11	$171.72
Amphion	B	8,970	101	339.96	107.06
Omsk	C	......	66	225.05	69.96
Osage	D	7,220	41	156.85	43.46
Oconee	E	4,116	35	137.50	37.10

The cost given for meals represents the average sea subsistence. On land the costs are as follows: For the *Nansemond*, $272.50 for meals and $100 for rooms; for the *Amphion*, $175 for meals and $86.50 for rooms; for the *Omsk*, $116.50 for meals and $44 for rooms; for the *Osage*, $77.50 for meals and $27.50 for rooms, and for the *Oconee*, $68.50 for meals and $27.50 for rooms.

All of the ships mentioned above are coal burners. The *Deepwater*, a class C ship corresponding to the *Omsk*, except for the fact that it is an oil burner, carried a crew of only 42 men. The wages of this crew per day amounted to $161.68. The saving in food costs over that required for the men on the *Omsk* was about $25 a day.

A national marine exposition will be held at the Grand Central Palace, New York, April 12-17, under the auspices of the National Marine League.

The Designers and Operators of Our Ships

BY JOHN FLODIN

Much has been said about the future of our merchant marine, about the evils wrought by recent legislative enactments, and about the status of the seamen. Yet the question of obtaining intelligent and efficient seamen has received but little consideration, and that usually in the form of comment on the relatively high wages paid—based on the demands of the maritime unions rather than on the increased knowledge or efficiency of the men. After summarizing the educational situation in the field, the author of this article submits a tentative programme for the training of ships' officers and ships' draftsmen, combining practical shipyard and sea experience with specially selected college courses.

THE establishment of training schools for seamen was one of the blessings of the war. These schools, when the courses are remodeled to suit peace-time conditions, will undoubtedly prove themselves of permanent and inestimable value. But how should these courses be modified? What requirements, what educational standards, should be established for deck and engine room officers of the merchant marine? It has been said that the time has long since passed when a sailor could build himself a ship—a statement that is, in general, quite true if by ship we mean a modern steamer. But shall we tacitly accept the idea that the sailor need have no more intimate acquaintance with his ship than he can get by sailing it? Should he not have some knowledge of the process of building that ship, of the problems that entered into its design? Ninety percent of the men I associated with during eight years of seafaring knew nothing of shipyards but what they had seen when the ships upon which they sailed were drydocked.

And, conversely, should a ship designer not have more than a vague idea of how a ship behaves at sea? Would it not be far better to bring these two maritime fields together in such a manner as to assure better co-operation, deeper mutual understanding?

> The fact that we must have a supercargo is a confession, first, that the ship owner and shipbuilder feel the need of information which they now lack, and, second, that the ships' crews cannot furnish the information needed. If the ships' officers cannot make the few observations desired, is it not an indication that some essential part of their training has been omitted? And is there not also something lacking in the training of the ship designer and ship operator? How many of our shipbuilders have had the opportunity of getting acquainted with a real ship in a real sea way on a real voyage? An experienced shipbuilder who held a responsible position with the United States Shipping Board recently confessed during a trial trip in rough weather that this was the first time he had realized that the stresses a vessel is subjected to are real and not mere imaginings that we deal with to satisfy Lloyd's or the American Bureau of Shipping rules.

Why Was the Supercargo Necessary?

Recently the United States Shipping Board announced the creation of a new post—the "supercargo." If the supercargo is to make observations that only the man at sea has the opportunity to make, and if these observations are to be used for the purpose of making the work of the shipbuilder and ship owner more effective, the intelligent supercargo will undoubtedly be worth his salary many times over. But the fact that we must have a supercargo is a confession, first, that the ship owner and shipbuilder feel the need of information that they now lack; and, second, that the ships' crews cannot furnish the information needed.

If the ships' officers cannot make the few observations desired—work that really should be a part of their daily tasks—is it not an indication that some essential part of their training has been omitted? And is there not also something lacking in the training of the ship designer and the ship operator? Both of these must, of course, be dependent on the reports of those who can personally observe developments; for we can scarcely expect the manager of a shipping firm to cross an ocean every time a new dock or a warehouse has been built somewhere on the other side, nor can we expect a shipbuilder to make a voyage on every ship he builds. But we can expect that both the ship owner and the shipbuilder shall have had an opportunity to gather first-hand knowledge of the things and of the conditions that will affect the success of their life work. What would you think of the president of a railroad company who engaged as manager, or even as division superintendent, a man who had never ridden in a railroad train and who had but a layman's knowledge of the various terminals of that road? What would you think of the president of an automobile manufacturing firm who hired as designer a man who had never ridden in an automobile, much less driven one? Yet, how many of our shipping men have even a fair first-hand knowledge of conditions and facilities in the ports to which they are sending their ships and their cargoes?

Shipbuilders Lack Sea Experience

And how many of our shipbuilders have had the opportunity of getting acquainted with a real ship in a real sea way on a real sea voyage? A man holding a responsible position with the United States Shipping Board told me some time ago of an experience he had had on a trial trip during which the weather had been rougher than usual. This, he confessed, was the first time he had realized that the stresses a vessel is subjected to are real, and not mere imaginings that we deal with to satisfy Llyod's or the American Bureau of Shipping rules. And he was a man advanced well into middle age, with many long years of shipbuilding experience behind him. Another instance: An Englishman, also a man of authority and of long and varied shipbuilding experience, admitted to me recently that the only chance he had ever had of

observing a ship working in heavy weather was when he immigrated to this country—and then he had been too seasick to know what was going on.

In spite of this glaring lack of sea experience on the part of a very large majority of our ship designers, there is a great deal of unwillingness among them to accept the advice or the suggestions of the seaman, as relating to questions of shipbuilding. This unwillingness is not entirely unwarranted, for not only is there a lack of confidence in the judgment of the seaman, but on the part of the seaman there is a real and decided lack of understanding of shipbuilding problems. It is true that the relations between the ship designer and the seaman, especially when the latter is serving as the owner's representative, are usually very cordial—on the surface at least—but there is nearly always an undercurrent of distrust, an unexpressed accusation of ignorance and incompetence. The seaman knows that the designer does not fully understand ship problems, because of lack of sea experience, and feels that he cannot make himself understood, while the draftsman feels that the seaman does not understand the engineering principles that must form the basis for every design. The designer is often a college graduate; the seaman almost never is. And why should he not be?

Inadequate Educational Facilities for Seamen

But is this lack of increased knowledge entirely the fault of the seamen? What has been done towards raising their standards? Very little indeed, and that little—known as the LaFollette act—has caused a never-ending storm of complaint and abuse, perhaps chiefly because the movement was staged by the seamen's unions. The high cost of living has been used as an argument for the obtaining of wage increases. It should be remembered, however, that the increased costs have affected seamen only in their buying of clothing and luxuries, since their food is included as part of their wages, and since they usually are not married. Yet, if we compare the work and life of the merchant seaman with the conditions obtaining in almost any field ashore, we cannot help feeling that the seamen are more sinned against than sinning. Up to the time of our entry into the war, what kind of educational facilities had we offered them? Of course, the public schools were open to them. But how often have we heard of an engineer, or a mate, or a steward asking the boy who is seeking his first job on shipboard whether he has graduated from any school, or even whether he can read and write? Seamen were not encouraged to attend school; indeed, the idea was generally prevalent that the sea was a good place for the boy who was good for nothing else, an idea that was probably a relic of the days when the galleys were manned by slaves and by convicts.

To satisfy the need for education specifically required by seamen who had enough ambition to want to get a license, a number of so-called navigation and engineering schools were established. They were private institutions conducted for profit, and a large part of the profit was derived by compelling the students to buy the very indifferent text-books written by the very indifferently qualified masters of the schools. It is scarcely necessary to add that the curriculum did not contain any information that would not be needed to enable the student to answer the questions that the inspectors would be likely to ask during the license examination. It is true that some universities were offering, and are still offering, courses in nautical astronomy. These courses, however, were not planned to fill the needs of the aspirant for a mate's license, nor were they of such a nature that he could be admitted to the classes without long, laborious and expensive preparatory studies. It is true that candidates for engineer's licenses could well have benefited by the courses in steam engineering offered at numerous colleges and universities, assuming that their preparatory schooling satisfied the matriculation requirements; but they were not encouraged to take advantage of these opportunities. In addition to these facilities, there were the training ships which gave their charges instruction in both seamanship and navigation, offering a somewhat more thorough training. These schools seemed intended primarily to reduce the hardships of the first years at sea, and to thus make the sea career somewhat more attractive, rather than to materially raise the standards. The facilities of this kind were, and still are, very limited.

> The courses here outlined could be offered with little additional cost by any university or college having an engineering department. If in selecting quartermasters and junior officers preference were given to men who had covered all or most of the educational programme decided upon, we would soon have available the necessary material for building up a corps of officers that would have not only a different educational standard, but also a different conception of their work and a new *esprit de corps*.

Many American universities and colleges offer two- and four-year courses in pharmacy to furnish the necessary preparation for the successful operation of a drug store. Most of our universities and colleges offer four- and five-year courses in commerce, and if the most successful graduates become bank presidents we feel that the educational expense was well warranted. The druggist can, through ignorance or carelessness, wreck but few lives and cause but little material damage before he is put out of business. The banker may, through lack of adequate training, cause considerable suffering, but he has not the power to *utterly destroy* lives and property. On the other hand, the seaman who climbs above the average of the rank and file, the man to whom we extend no educational helping hand, has it in his power to obliterate the lives of scores, possibly of thousands, of human beings and millions in property.

Efficiency a Product of Education

We have been told that it is difficult, if not impossible, for the American merchant ship to compete with foreign shipping because of the higher pay of the American sailor, both in cash wages and in the greater expense for better and more abundant food. It has been pointed out that higher wages and better food do not necessarily mean greater efficiency, since American vessels are compelled to carry larger crews than ships flying foreign flags. Would this not assume a different aspect if our seamen were educated and trained, not with any intention of reducing the size of the crews, but with a view to obtaining the services of men who would be able to suggest improvements and to offer intelligent criticism? I am not asking that we find or create crews of inventors for our ships. Education and training do not produce inventors—a child may conceive the idea of utilizing the energy contained in steam; but education and properly guided training do produce men who are capable of improving existing inventions—men who can refine the steam engine until

its fuel consumption is cut down to but a fraction of what had been thought possible.

Educational Programme for Ships' Officers

The question of just what would be the most desirable educational preparation and training for these men requires careful consideration on the part of all those who are connected with shipbuilding and shipping. As a very preliminary outline of what should be regarded as a transitory step, the following might serve:

Deck Officers

First two years, at sea, six months of which should be spent in the engine room, on board a merchant or training ship.

Third year, special college course, comprising the following subjects:

- Mathematics—rapid survey of elementary mathematics, including logarithms; solid geometry; a brief course in trigonometry, including the elements of spherical trigonometry
- Mechanical Drawing
- Mechanics and Strength of Materials—as complete an exposition as can be given without calculus, with special reference to the strength of a ship as a whole
- Shipbuilding—types of ships; general survey of powering and resistance problems
- Steam Engineering—a course of descriptive nature, covering steam engines, turbines, boilers and auxiliaries.

Fourth year, in the shipyard, preferably under special apprenticeship arrangement, whereby the time can be divided among several departments, such as the mold loft, the fitting department and the hull drawing office.

Fifth year, special college course, comprising the following subjects:

- Mathematics—a brief course in differential and integral calculus
- Nautical Astronomy
- Navigation and Rules of the Road
- Commerce and Commercial Geography
- Ship Caluculations, with special emphasis on stability
- Medicine—first aid, diagnosis and treatment of common ailments, hygiene.

Engine Room Officers

First two years, at sea, six months of which should be spent on deck, on board a merchant or training ship.

Third year, special college course comprising the same studies as for deck officers.

Fourth year, in the shipyard, preferably under special apprenticeship arrangement whereby the time can be divided among several departments, such as the pattern shop, the machine shop and the machinery drawing office.

Fifth year, special college course comprising the following subjects:

- Mathematics—a brief course in differential and integral calculus
- Mechanisms
- Steam Engineering—a descriptive course covering steam engines, steam turbines, boilers and auxiliaries
- Steam Engine Design, with special reference to valve motions
- Steam Boiler Design
- Engine and Boiler Testing, with special reference to indicator work, including valve setting from indicator diagrams
- Internal Combustion Engines—a descriptive course
- Dynamos and Motors—a descriptive course, but including the principles of electricity and magnetism
- Ship Calculations—including resistance and powering, with special reference to propeller problems
- Medicine—first aid, hygiene.

It will be noted that the college work is cut down to the barest essentials, representing one-half the time outlay required for the engineering courses offered as preparation for work of considerably less importance and responsibility. At present we send a man to college for four or five years as part of the preparation for his taking charge of a power plant where a breakdown is not likely to have any more serious result than an unpleasant interruption of service. On the other hand, the man we place in charge of a *ship's* power plant is not encouraged to spend a single day in college, and we are more likely to inquire into the number of years of sea experience he has had than into his high school career. Yet such a programme as is here outlined could readily be put into execution without very great expense. The nature of the courses outlined is such that they could be offered by any university or college having an engineering department at but little additional cost, and their installation at the present training schools should not prove a very difficult task.

Proposed Courses for Ship Draftsmen

The training courses proposed above, up to and including the first year of college work, are so similar that a change could be made from one branch to the other without great loss of time if a student so desired. It should also be clear that all or any part of this training would be a very useful asset to ship draftsmen, although the following suggested schedule would serve as a better preparation for that field of work:

Hull and Engine Draftsmen

First two years, at sea, about one-half of which should be spent in the engine and boiler rooms, dividing the time preferably among several merchant ships.

Third year, special college course comprising the following subjects:

- Mathematics—algebra, trigonometry, solid geometry, with special reference to the geometry of shipbuilding
- Drawing, including elementary problems in descriptive geometry
- Mechanics and Strength of Materials, with special reference to ship work
- Mechanisms
- Shipbuilding—types of ships, tonnage, laying-off
- Ship Calculations—elementary course
- Steam Engineering—elementary course, both descriptive and analytical

Fourth year, special college course comprising the following subjects:

Hull Draftsmen

- Mathematics—a brief course in differential and integral calculus
- Ship Design—general considerations, structural drawing, hull fittings, rigging and rigging details
- Ship Calculations—continuing and supplementing the first-year course
- Commerce.

Steam Engineering Draftsmen

- Mathematics—a brief course in differential and integral calculus
- Steam Engine Design
- Steam Boiler Design

- Engine and Boiler Room Auxiliaries
- Internal Combustion Engines—descriptive course
- Steam Turbines—descriptive course
- Engine and Boiler Room Piping
- Ship Calculations—resistance and powering, with special reference to propeller design
- Commerce.

These very brief courses of preparation should be rounded off with a one-year apprenticeship arrangement in the shipyard, by which the student is permitted to spend a short time in each of several departments.

Naval Architects and Marine Engineers Need Sea Experience

It is not intended that the courses here outlined for ship draftsmen should supplant the four- and five-year courses now being offered in naval architecture and marine engineering. On the other hand, they are intended rather to replace the present apprenticeship arrangements, which in practically all our shipyards leave the youth to pick up what he can during working hours and to get supplementary—and often ill-suited—instruction in evening schools at his own option. Not only have I no desire to weaken the present longer courses, but I should like to have them strengthened by adding the requirement that the student spend at least his vacations at sea, or, preferably, his vacations in the shops of a shipyard and one or two years at sea after graduation, or between his fourth and fifth collegiate years in case he is taking a five-year course.

The Probable Effect of the Proposed Programme

It may perhaps be objected that this educational scheme would tend to give rise to an aristocracy on shipboard and in shipyards. I think we have at the present time about all the aristocracy on shipboard that one could wish, but this aristocracy is not based, to as large an extent as it should be, on mental superiority. Anyone familiar with sea life knows how sharply the lines are drawn between the men "before the mast" and the men holding officers' berths, although little mental difference exists. In shipyards the spirit is more democratic, and I think it may truthfully be said that the college-trained men who have entered this field have not been guilty of making it less so.

If, in selecting quartermasters and junior officers, preference were given to men who had covered all or most of the educational programme decided upon, we should soon have available the necessary material for building up a corps of officers that would have not only a different educational standard, but also a different conception of their work and a new *esprit de corps*. When this has become apparent, men will not drift into sea life with the intention of sailing a few years, haphazard, and then perhaps taking a six-months' course in navigation or steam engineering in order to get a license. Under that system a man picks up what he can, usually without guidance. His experiences are often of the richest, but his education is usually too meager to enable him to derive even a reasonable amount of benefit from them.

New System Would Attract Better Men

Perhaps, however, the greatest benefit accruing from the raising of the standards—or, better, from the establishing of educational standards—would be to stimulate American young men to take up sea life. Some time ago a young man, a high school graduate, told me that the reason why he had quit the sea, after having sailed for two years, was that he found that he was forgetting more than he was learning. The prospect of becoming an officer had not appealed to him, he said, because even as an officer he would have had to recognize as his superiors men who, he felt, were more ignorant than he. He probably attached too small importance to the value of practical experience.

On the other hand, a large majority of the men going to sea would probably object to the idea of attending college or even high school classes. The average boy, who scoffs at higher education, harbors a secret ambition to show the world that he can successfully compete with men of greater educational attainment. When he begins to realize the greatness of the handicap, he very often—usually secretly—takes night school or correspondence courses. He is not easily discouraged and does not readily give up the race. He wants to be, and often, simply because of the stimulus of keen competition, turns out to be "as good as the next man."

But such competition does not now exist either on shipboard or in the drawing offices of our shipyards. After a man "serves his time," if he has chosen the sea, he takes an examination that represents a minimum of knowledge; subsequently, the question of whether or not he is really qualified to fill an officer's berth is left to the arbitrary decision of the captain, the chief engineer, or the owner of the ship, who, of course, must accept some one of the candidates, even though he may feel that the education or training of the man chosen does not warrant placing great responsibility in his hands. If the man happens to be a draftsman, his rating is determined (according to the Macy board award) on the basis of the number of years of experience he has had. This training may or may not have made him a real asset to the industry and to the country.

American Ship Men as Leaders, Not Followers

Doubtless any improvement in shipbuilding or ship operation which might be brought about by men thus trained at national expense would soon be copied by other countries. Therein lies the secret of success. If we can lead and innovate where we have been copying and imitating, if we can keep our beacon shining a little in front o' the next, and leave him sweating and groping a year and a half—or a decade and a half—behind, we need not fear for the future of the American merchant marine.

Trials of the First Steamer Completed by the Australian Government

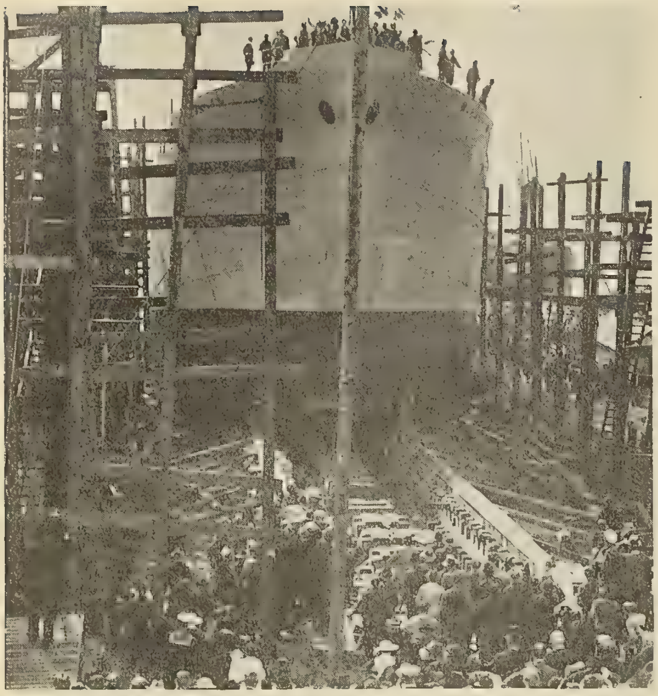
THE S. S. *Dromana*, the first ship to be completed under the Australian Commonwealth shipbuilding scheme, ran her trials on August 9, 1919. The trials were in every way satisfactory, the vessel attaining a speed of 11.8 knots.

The party on board included the Hon. A. Poynton, minister in charge of shipbuilding; members of the Federal Government, and a representative of the Victorian State Government; representatives of Melbourne commercial circles; Mr. Rex. Thompson, representing the engineers; Mr. H. W. Curchin, chief executive officer of Commonwealth ship construction, and Mr. Watson, engineer of the ship construction department.

The vessel has a length of 341 feet, a beam of 48 feet, and a molded depth of 26.1 feet. She is built on the Isherwood system of longitudinal framing, of single deck type, with poop, bridge and forecastle, and classed 100 A-1 at Lloyds. She has exceptionally large hatches and ample cargo handling equipment, consisting of eleven winches and eleven derricks, including one 20-ton derrick The captain and officers are berthed amidships, the

S. S. *Dromana*, 5,600 Tons Deadweight, the First Ship Completed Under the Australian Commonwealth Shipbuilding Programme

On the Deck of S. S. *Dromana*, Hobsons Bay, Melbourne, August 9, 1919



Launching of S. S. *Dromana* at Williamstown on April 11, 1919

engineers being on the bridge alongside the engine casings. The crew is berthed in the poop. All accommodations are ample in size, with separate mess rooms for firemen and sailors, as well as baths and washrooms.

The vessel will carry 5,600 tons deadweight on a 21.9-foot draft and was built at the Commonwealth Government yard at Williamstown.

The machinery consists of triple expansion engines with cylinders 25, 41 and 68 inches diameter and 45-inch stroke, and three Babcock & Wilcox watertube boilers designed for a working steam pressure of 180 pounds per square inch. The machinery was constructed by Messrs. Thompson & Company, Castlemaine, Victoria. With the exception of a portion of the steel plates, special parts for the boilers and a few items of equipment, the material and auxiliaries were manufactured in Australia.

Australian Federal Fleet Construction

THE Australian Commonwealth Government, in pursuance of a policy of shipyard expansion, is carrying out an extensive programme of new construction. At the Government Dockyard, Walsh Island, Newcastle, a contract for three 12,000-ton steamers has recently been placed. These ships are to be used in the meat-carrying trade, and for this purpose the holds will be insulated and up-to-date refrigerating equipment installed. Although the Newcastle yard is the largest in Australia, additional machine equipment is necessary to accommodate these vessels because of the previous contracts being carried on simultaneously.

Construction of six vessels of the *Delungra* type, built on the Isherwood system, is progressing rapidly. Two of the vessels launched in the spring are approaching the point at which they can be taken on their trials, while a third, the *Dundula*, was launched in July. The preparation of the plates, frames, etc., for the remaining three was carried out on a production basis at the same time, so that the remaining work is practically an assembling proposition.

These ships are of the well-deck type, having the following dimensions:

Length	331 feet
Beam	48 feet
Molded depth to upper deck	26 feet 1 inch
Deadweight tonnage	5,500
Engines	Triple expansion
Indicated horsepower	2,200
Boilers	Babcock & Wilcox
Speed	10½ knots

The vessels are being built at an average cost of $775,000 (£159,000).

Additional Building Programmes

In addition to the first contracts, fourteen more vessels are contemplated immediately. Two will be built at the Commonwealth Dockyard, Williamstown; three at the Dockyard, Walsh Island; one at Cockatoo Island; four at Walkers, Ltd., Mayborough, Queensland, and four at Pool & Steel's, Adelaide. All these ships are to be of the shelter deck type of the following dimensions:

Length	331 feet
Beam	48 feet
Molded depth to upper deck	33 feet 7 inches
Deadweight tonnage	6,000
Engines	Triple expansion
Indicated horsepower	2,200
Boilers	Babcock & Wilcox

Auxiliary Schooners

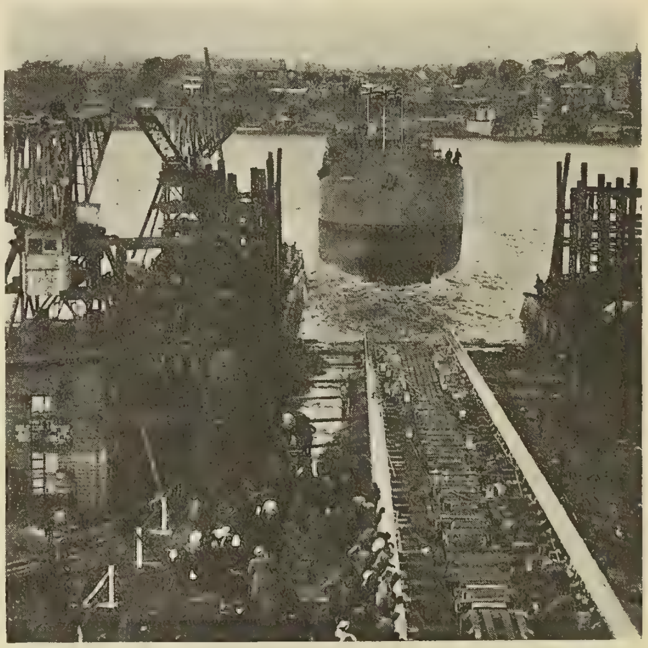
Two wooden five-masted auxiliary schooners are under construction. The dimensions of these vessels are:

Length	250 feet
Beam	45 feet
Molded depth	24 feet 5 inches
Deadweight tonnage	2,600
Engines, two sets	Bolinder semi-Diesel
Brake horsepower, each	240
Revolutions per minute	240
Speed	7 knots

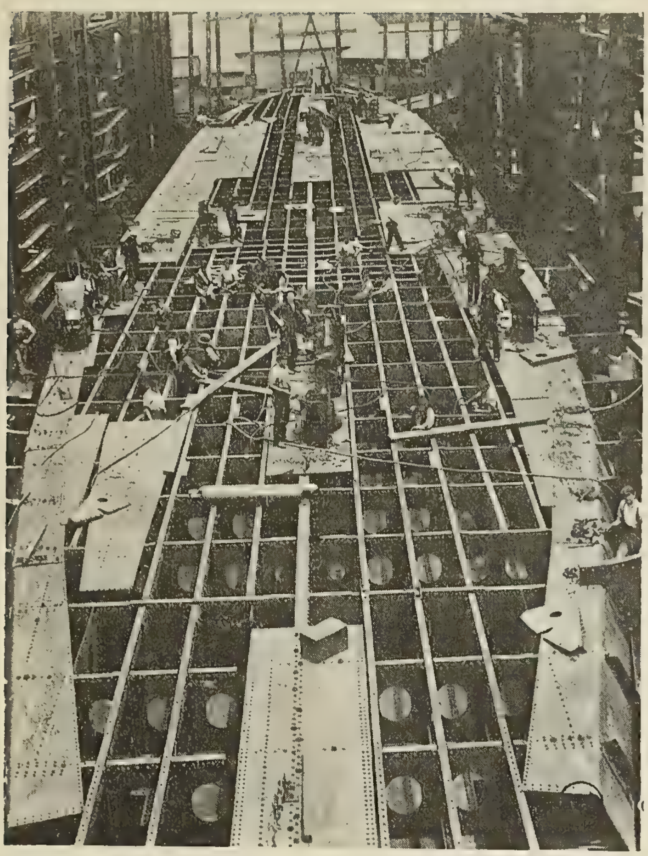
The contract price for the vessels is $130 (27/1/8) per deadweight ton.

Proposed Contracts

Negotiations have been completed for the construction



Launch of the S. S. *Dundula*, Third of the Commonwealth Standard Ships, from the Commonwealth Naval Dockyard, Sydney, N. S. Wales, July 9, 1919



Steamship *Dundula* in Course of Construction, Showing Riveters at Work on Tank Top

of four vessels larger than any previously planned, with the possibility of two additional later. The details of the construction are:

Length	520 feet
Beam	62 feet 3 inches
Molded depth	45 feet
Deadweight tonnage	12,800
Speed	13 knots

The holds will be so arranged that 260,000 cubic feet of insulated space will be available for the stowing of frozen meat or chilled produce. The vessels will each cost about $2,115,000 (£412,500).

Steamship Dundula

At the Cockatoo Island yard the third vessel, the *Dundula,* contracted for on the original programme, was launched July 9, 1919. This vessel is of the single-deck type, with a long bridge deck amidships. The crew is accommodated in the poop, the officers and engineers on the bridge deck, and the captain and wireless operator on the navigating bridge. All the ship's stores are carried in the forecastle. There were altogether 1,460 tons of steel used in building the vessel, of which about 876 tons were fabricated in Australian steel mills. The pumping and drainage arrangements are very complete for a vessel of this size.

The main framing of the vessel consists of bulb angles averaging from 7 inches to 9 inches, running nearly the full length of the vessel at a distance of 28 inches apart. They are supported by transverse frames, which consist of web plates varying in depth from 14 inches to 42 inches and supported by face angles connected to the plating.

The transverse frames, which are spaced from 11 to 12 feet apart, form a continuous web with the upper deck beams. The longitudinal and transverse framing, together with the shell and deck plating, form the main factor of strength in this type of vessel. Five watertight bulkheads add to the strength and stiffness of the structure.

The collision bulkhead is situated about 20 feet from the forepeak. At the after side of this bulkhead the cargo hold begins and extends about 140 feet to the coal bunkers. Aft of the coal bunkers are the boiler and engine rooms, and another cargo hold which extends to within 35 feet of the stern frame. The vessel is designed to carry a cargo of 5,500 tons deadweight. She will displace about 9,000 tons when fully loaded.

Power is provided by steam generated in three Babcock & Wilcox boilers of the watertube type having a heating surface of 8,289 square feet. Only those parts have been imported which could not be made in Australia.

The engines were manufactured by Messrs. Thompson & Company, of Castlemaine, Victoria. They are of the triple expansion type, 25 inches by 41 inches by 68 inches cylinder diameter, and 45-inch stroke. They will develop 2,200 indicated horsepower. The same type engines are being installed in the class-C ships in Great Britain. They weigh about 100 tons; their dimensions are: length, 21 feet 3 inches; width, 16 feet; height from the sole plate to the top 23 feet.

The auxiliaries include the condenser with a cooling surface of 2,600 square feet; several large Weir-type feed pumps, ballast pumps and a 25-ton evaporator. The Weir-type pump has proved itself quite the best for the purpose and is generally installed in Australian ships. Other accessories, all of which have been turned out in the Dockyard workshops, comprise pumps, feed heaters, filters, condensers, winches, electric light engines, windlasses, steering engines, auxiliary screw gear, ventilating fans and fan engines, etc.

Steamship Coaling Equipment*

A SELF-CONTAINED coal digging unit intended for use in coaling ships through side ports has been arranged to hang on the side of the steamship to be coaled, Fig. 1. The machine may also stand on the deck of a steamer near the rail, and by using cars, wheelbarrows or portable conveyors the coal can be loaded into the deck hatches.

Self-filling grab buckets are universally used throughout the world for digging coal from barges and discharging at coaling stations on shore. It is quite certain that this is the only practical and economical way to handle soft coal. A number of these shore digging plants have been designed and installed for the Navy Department. The steamship coaler is really a miniature of the shore plant.

Construction of Coaler

The machine consists of a light structural steel *A* frame to which is attached the hoisting motors and machinery. The frame also supports the receiving hopper with a telescopic flexible chute at the bottom. The lifting boom is pivoted on the *A* frame and the bucket is suspended by ropes from this lifting boom.

A seat is provided for the single operator with convenient control levers. An extension hook is provided at the top of the *A* frame so that the machine may be hung from the bulwark or side plating of a steamship. Heavy chains with hooks are also provided to take the weight of the machine, as shown by the illustration, in which case a top lashing or turnbuckle with a hook is used to take the outboard pull of the machine at the top.

The grab bucket is a standard clam shell, self-filling bucket of the same type used in shore plants and has a capacity of one-third of a ton of bituminous coal. The

* Courtesy of Bergen Point Iron Works, Bayonne, N. J.

topping up of the boom is automatically controlled by a conical-shaped differential drum, shown in Fig. 2. The operator has only to hoist and lower the bucket, which automatically swings in over the hopper to its dumping position without attention on the operator's part.

Operation of the Bucket

The maximum reach of hook is 14 feet from the center-line of the machine and the minimum reach is 9 feet 9 inches. By utilizing the swing or pendulum motion of the bucket when lowering, this is ample to take care of barges up to 32 feet beam. The hoisting and closing motors are of 15 horsepower each and can use either direct current or alternating current. An electrical connecting plug is provided on the machine so that a wire can be run from the steamship to furinsh the machine with current.

The bucket has a capacity of 50 tons an hour when there is plenty of coal within reach. This capacity, however, is reduced somewhat when the bucket is cleaning up coal from the bottom of a barge.

Method of Installing Coalers

The total weight of the machine is about 4½ tons and it can be quickly and easily hung in place on the side of the steamship by means of a derrick lighter. About five minutes is required for the derrick lighter to hoist and hang the machine in place, and even less time to take it down.

It should be noted particularly that the whole machine is self-contained, and after hanging in place all that is necessary is to put in the electric plug before beginning operations.

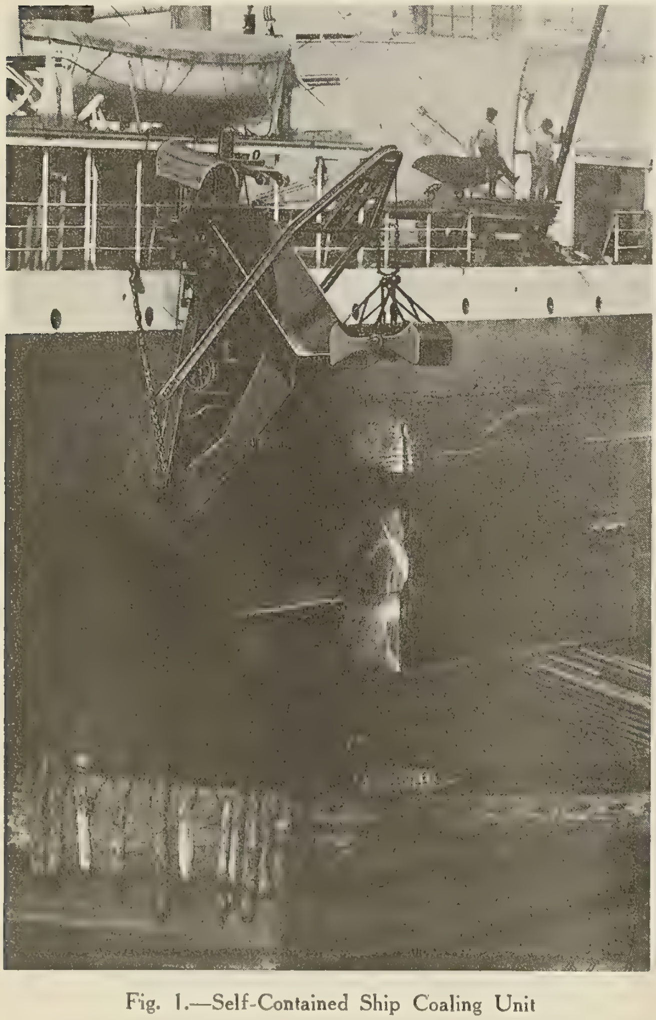


Fig. 1.—Self-Contained Ship Coaling Unit

A number of machines should be stored on a derrick lighter which is to be used to hang the machines in place. For hanging the machines on the inshore side of the steamship, adjacent to the dock, the machines should be stored on the dock and swung in place by a derrick from the dock. The best method is to design the derrick lighter with a very low clearance line, so that the lighter might go underneath the mooring lines and gangplanks.

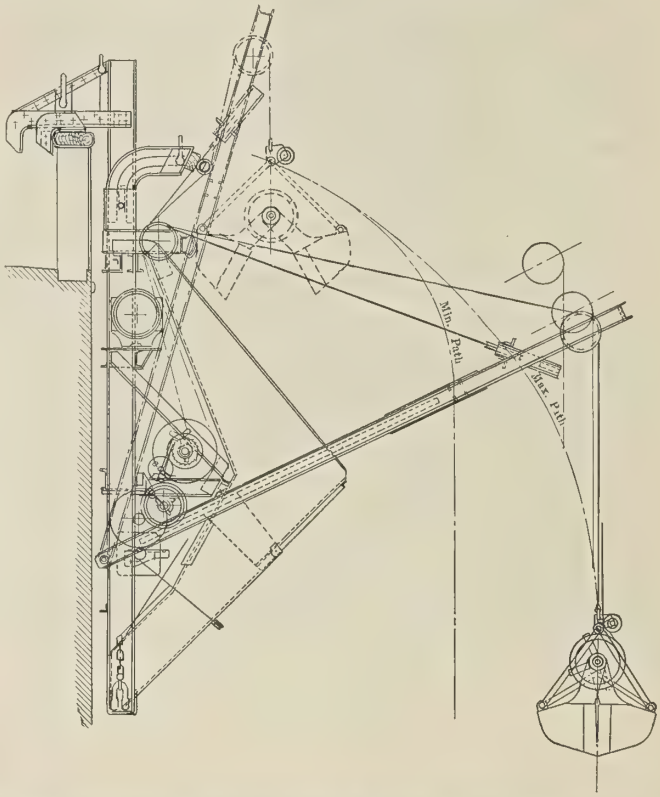


Fig. 2.—Details of Coaling Equipment, Showing Method of Operation

It is claimed that a single operator on a coaler will handle more material than a stevedore's gang with hand-filled tubs. Such a stevedore's gang usually consists of twelve to fourteen men. When cleaning up the bottom of the coal barge with the bucket a couple of trimmers will be required in the barge.

Ship Construction and Marine Transportation Added to Courses of Study at Lehigh University

LEHIGH UNIVERSITY offers a four-year course in ship construction and marine transportation leading to the degree of naval engineer (N.E.). Its purpose is to prepare men to engage in the design, construction and operation of ships, and to enter the field of marine transportation. The course is a combination of engineering and economics preceded by the fundamental subjects common to engineering courses; chemistry, modern languages, physics and mathematics. Combining, as it does, engineering training with studies in economics and business administration, such a course has been planned to develop men who, in addition to a knowledge of conditions governing ocean and inland water transportation, will have a command of the technical, economic and financial aspects of ship design, construction and operation. The course is as follows:

THE COURSE IN SHIP CONSTRUCTION AND MARINE TRANSPORTATION

FRESHMAN YEAR

First Term	*Second Term*
Advanced Algebra (3)	Plane Analytic Geom. (3)
Elementary Chemistry (2)	Spherical Trigonometry (1)
Chemical Lab. (2)	Qualitative Analysis (3)
Elementary Mechanics (3)	Stoichiometry (1)
French (3)	Elem. Mech. & Heat (3)
or Spanish (3)	Physical Measurements (1)
or German (3)	French (3)
Engineering Drawing (3)	or Spanish (3)
Construction (2)	or German (3)
Gymnasium (1)	Engineering Drawing (2)
	Construction (2)
	Gymnasium (1)

Summer Term: Land and Topographic Surveying

SOPHOMORE YEAR

First Term	*Second Term*
Differential Calculus (4)	Solid Analytic Geom. & Integral Calculus (4)
Electricity & Magnetism (3)	Light & Sound (3)
Mechanics & Heat Lab. (1)	Light, Elec. & Mag. Lab. (1)
English (3)	English (3)
French (3)	French (3)
or Spanish (3)	or Spanish (3)
or German (3)	or German (3)
Economics (2)	Naval Architecture (2)
Ship Construction (3)	Accounting (2)
Physical Education (1)	Ship Construction (2)
	Physical Education (1)

Summer Term: Work in Shipyard on Hull Construction

JUNIOR YEAR

First Term	*Second Term*
Strength of Materials (4)	European History (3)
Strength of Materials Lab. (1)	Hydraulics (3)
Naval Architecture (3)	Hydraulic Lab. (1)
Dynamos & Motors (2)	Alternating Currents (2)
Dynamo Lab. (1)	Dynamo Lab. (1)
Heat Engineering (3)	Marine Engineering (3)
Business Law (2)	Steam Engineering Lab. (1)
Astronomy & Navigation (2)	Finance (2)
Physical Education (1)	Machine Design (3)
	Physical Education (1)

Summer Term: At Sea or in Shipyard Machine Shop

SENIOR YEAR

First Term	*Second Term*
Naval Architecture (2)	Metallurgy (3)
Ship Design (3)	Ship Design (4)
Marine Engines & Turbines (4)	Reinforced Concrete (3)
Steam Engineering Lab. (1)	Contracts & Specifications (2)
Structural Steel Design (4)	Foreign Trade (4)
Foreign Exchange & Marine Insurance (3)	Shipyard Plants & Terminal Facilities (3)
Industrial Management (2)	Physical Education (1)
Physical Education (1)	

The Dangers of the Oil Room

BY S. D. RICKARD*

IN considering the dangers attendant upon the storage and handling of oils, we are apt to think only of gasoline (petrol) and naphtha. This is a great mistake, as every oil carries with it a menace to life and property, and its handling should be safeguarded in every possible manner. Until this fact is universally recognized and all oils are handled in fire-proof, evaporation-proof steel storage tanks, we must expect to pay an enormous fire loss due to the careless handling of these products. It is true that the danger of handling gasoline (petrol) is greater than in handling other oils. This danger is so well known, however, that familiarity with it has in many cases induced carelessness, so that it is well that we consider the treacherous nature of this product, that we may always be on our guard.

Gasoline (petrol), unlike the other heavier petroleum products, throws off an explosive vapor constantly, even at extremely low temperatures. Five gallons of gasoline (petrol) will generate 8,000 cubic feet of gas, which, when ignited, expands to 4,000 times this space. The explosive force of one gallon of gasoline (petrol) properly mixed with air and compressed is equal to 83⅔ pounds of dynamite, or fourteen times greater than dynamite. This means that if you have 100 gallons of gasoline (petrol) on hand, you are storing the equivalent in explosive force to 8,366 pounds of dynamite. Gasoline (petrol) is, in fact, more dangerous to handle than dynamite, and there is more liability of an explosion. Dynamite will only explode from two or three causes, which may be easily guarded against and which must occur in its immediate vicinity.

Dangerous Gasoline (Petrol) Fumes

The vapor from gasoline (petrol) is heavier than air. It settles to the floor and runs along the floor much as a stream of water would, only that it is an invisible stream. This vapor will settle and remain in a depression in the floor or under the floor for days and even weeks, unless disturbed by a circulation of air, until a spark causes the accumulated vapor to explode. This spark does not necessarily have to come from a lighted fire, but may occur through a person striking a nail in their shoe on a nail in the floor or other similar unavoidable causes. The records show that under certain atmospheric conditions, spontaneous combustion will occur in this accumulated vapor. A case is on record in which the gasoline (petrol) fumes were carried outside of a building to a lighted lamp thirty feet away from the building, taking fire and flashing back to the building, which was entirely consumed. If you are handling gasoline (petrol) in any way but the right way, you are in just this position and you can never foresee when the blow will fall.

It is past understanding, in view of these facts, that many concerns, with their entire capital invested in the business, will give so little thought to safeguarding their interests. With the factory, shop, mill or mine heated, they will at night lock up this explosive in a warehouse or building adjacent to or connected with the main plant. After locking up fire and this explosive vapor together, they will, in effect, wager their entire investment against the merely nominal expense of fire-proof storage that this vapor and this fire will not get together.

Kerosene (paraffin) is not as dangerous as gasoline (petrol), yet at a temperature of 70 degrees F. or over it throws off an explosive vapor. At a higher temperature, say 80 degrees F., in order properly to ventilate a room in which there is an open tank of kerosene (paraffin), there should be kept up a circulation of air equal to 200 cubic feet per minute for each gallon of the exposed oil. These figures vary, of course, with the volatility of the oil and the temperature of the air and oil. Such a circulation of air is not practical in the usual manufacturing establishment. Hence the necessity is apparent for evaporation-proof, scientifically correct storage for kerosene (paraffin), as well as for gasoline (petrol).

Dangers from Paint Oils

All petroleum products, including lubricating oils, produce this explosive vapor. The danger from lubricating oils, however, is chiefly from spontaneous combustion where waste, sawdust or shavings are used to absorb the oils spilled on the floors. Many fires in factories and oil rooms have been traced directly to this cause, as it is a very common practice to neglect the accumulated refuse, which, in time, bursts into flames.

The gravest danger that confronts the consumer of oils aside from the gasoline (petrol) danger is, however, from

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the paint oils, such as linseed oil and turpentine. A piece of cotton waste saturated lightly with equal parts of linseed oil and turpentine will, if left in a closed room, such as an oil house or storeroom, for the night, burn from spontaneous combustion in three hours' time. Instances are not even lacking of fires being started in this manner when the waste or oil-soaked cloth was left in the open air. Two years ago a fire occurred in Minneapolis from a cloth which had been used in oiling a floor and was left on the porch. North Dakota has, in the past year, suffered a loss running up into hundreds of thousands of dollars from fires started by spontaneous combustion in oil houses. This property loss is appalling, but who can estimate the value of lives sacrificed annually to the mistaken policy of "economy" in equipping an oil room?

We are living in an age of increasing danger to life and property from many causes unknown to our fathers. Developments of modern inventions in all lines, such as electricity, automobiles, etc., each brings its corresponding increase in danger to life and property. These advances in the development of our civilization bring a responsibility that we cannot ignore. The merchants and the factories today are compelled to meet the conditions. For instance, they are compelled to store large quantities of various dangerous oils. Happily, we are also in an age when master minds have set themselves to the problem of minimizing all such dangers. The storage and handling of oils has been reduced to an exact science, so that there are now available means of handling gasoline as safely as spring water.

Safety Equipment for Handling Oils

Special equipment has also been designed for handling each and every oil in a manner best suited from the standpoint of economy, convenience and safety. The up-to-date merchant today is taking advantage of these appliances, so that we may in confidence look forward to a time when fires caused by careless handling of oils will be unknown. This will be brought about by various causes. The instinct of self-preservation is strong with everybody, and all must realize the risk in the careless handling of explosives. The fact that these safety appliances conserve the efficiency of the product, preserve the quantity intact and enable losses to be turned into profits brings enormous pressure to bear upon the thoughtful man. Public opinion, national and state safety boards will soon demand that every man will at least cease to menace his neighbor's property and his neighbor's life by unnecessarily lax methods in the handling of dangerous explosives.

The increasing prices of all kinds of oil and general economic requirements demand the proper storage and distribution of these liquids. Millions of dollars are lost annually due to the deterioration of the quality and waste in handling improperly stored oils. Hot and cut bearings, prematurely worn machinery, are very frequently due to deteriorated or contaminated oil. This enormous loss is usually never traced to the right source—poor oil storage. The same criticism can be made of improperly stored paint oils, varnishes, dryers, etc. Competition in practically all lines demands economical production; that means elimination of waste so far as possible in every department of the industry.

Your oils, etc., can be checked in as they are received and accurately recorded as they are used. You can keep just as accurate account of your oils as you can of your tools.

All railroads, mines or manufacturing institutions maintain stockrooms for the purpose of receiving and distributing all of the supplies used by the institution. This is considered absolutely necessary in order to reduce losses and to maintain a cost system.

Money is invested in oils just the same as any other supplies; yet it is a known fact that in most institutions no record is maintained as to the quantities received or dispensed. The purchasing, storing and the distributing of lubricating and paint oils, gasoline (petrol)), naphtha and other similar liquids is just as much a science and a part of the shop cost system as any other department.

Industrial plants of all kinds, especially railroads, are experimenting continually to learn how the cost of lubricating can be reduced and methods improved, forgetting apparently to investigate the oil house of the storeroom where the oils are stored and issued—the place where the percentage of loss is usually the greatest.

The installation of a modern storage system for oils, etc., need not necessarily imply the outlay of large sums. We have found this "big investment" idea on the part of men in charge of industrial institutions has frequently prevented them from considering the purchase of equipment. It is not always necessary, or even advisable, to put in at one time all the equipment the management might feel would be needed ultimately. In many instances storage is provided for those oils or other liquids which most urgently require it. The balance of the equipment can be added as finances permit or exigencies demand.

Modern Storage Systems

Modern storage equipment for handling liquids is really divided into two general types—one for handling volatile liquids, such as gasoline (petrol), naphthas, paint oils and varnishes, and the other for handling non-volatile liquids, such as lubricating oils.

The first of the two general types requires underground storage tanks for gasoline (petrol) or naptha, and aboveground storage for the paint oils and varnishes. This arrangement usually meets with the demands of the various state laws governing this type of storage. Where underground tanks are required, they should be cylindrical in design. If made of galvanized steel, all seams and rivets should be carefully made and then soldered inside and out. If heavy metal is used—much as three-sixteenths steel or heavier weights, as conditions or the capacity of the tank may make necessary—then all seams and rivets should be carefully calked. Storage tanks for volatile liquids require special care in construction. A tank may hold water or steam pressure, but it is usually unfit for volatile liquid storage purposes.

Pumps

Specially designed pumps of either measuring or non-measuring type are connected by pipe lines to tanks buried underground or inserted in the top of tanks for above-ground use. Accurate devices are provided on the measuring pumps for the delivery of desired quantities of liquids. Gear-driven meters may be added for the purpose of checking consumption. Locks are supplied on both types of tanks and on the pumps as well. This prevents unauthorized usage and theft.

Where a battery of individual units is used, barrel track and barrel drainers are used in connection with small chain hoists. This makes it very easy to handle the barrels and drain them completely into the manhole of the tanks. This saves labor, time and liquid and prevents the loss of liquid due to the return of liquid in barrels which have not been properly drained by the old style spigot method. Dirt, dust and sediment are kept from the liquids, fire danger is entirely eliminated, valuable storage space is saved, labor is lessened, cost and consumption are easily arrived at.

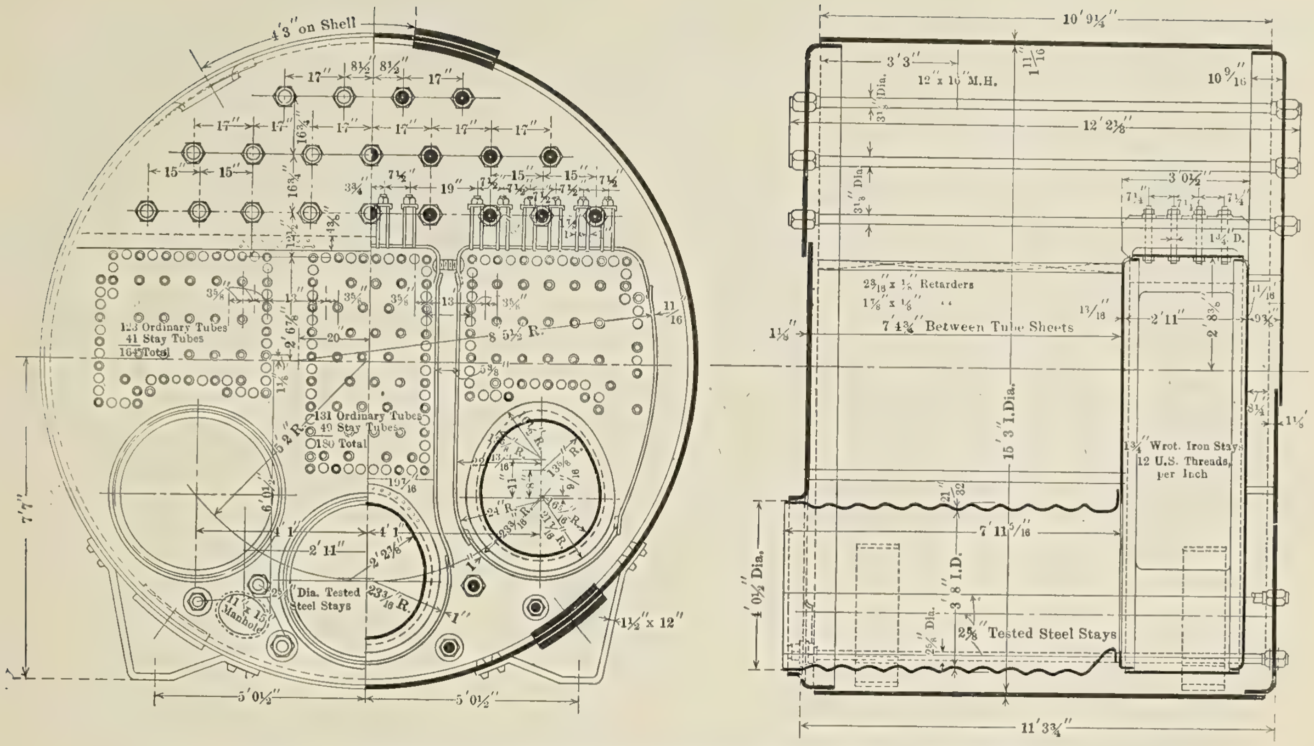

Fig. 1.—General Arrangement of Scotch Boiler as Used on Ships of the Emergency Fleet Corporation

Boilers of the New Emergency Fleet

Comparative Results Obtained with Scotch and Watertube Boilers—Relative Costs and Weights and Service Records—Details of Construction

BY JOS. J. NELIS*

BEFORE the world war the American merchant marine had for a number of years consisted of a very small proportion of the world's tonnage. Owing to its restricted size, operating engineers and designers were inclined to follow established foreign precedence as regards propelling equipment. Therefore, nearly all American merchant ships were fitted with Scotch marine boilers and triple expansion engines. This equipment, when properly handled by trained crews, gave satisfactory service as regards reliable operation. Reliability in operation is the most essential requirement of marine propelling equipment, but economy of operation, while desirable, has in the past been neglected owing to the conservatism of marine engineers in all countries.

The development of the watertube boiler in land plants has shown it to be considerably more economical than the firetube boiler, but it had not been adopted to any great extent by the American merchant marine. The Amreican navy, however, and practically all foreign navies, have adopted the watertube boiler almost exclusively on account of its lower weight, reduced size, greater economy and much greater capacity than the Scotch boiler.

Demand for Boilers Created by the War

When America entered the world war in 1917 the necessity for a larger merchant marine, which had been well known for a number of years by all naval and marine interests, was suddenly discovered by the rest of the country, as the necessity arose for transports for our troops and their supplies. The Government promptly formed an organization to build ships and also requistioned all the ships then building in the shipyards of the country. A review of the situation at that time showed that the requirements were so vast that it would be necessary to develop a number of new shipyards and to expand the American merchant marine tremendously in the shortest possible period of time.

This programme was handled for the Government by the Emergency Fleet Corporation, and at one time contracts had been entered into for more than 14,000,000 deadweight tons of shipping. This included both the requisitioned ships then building, which were taken over by the Government, and new contracts for ships made by the Emergency Fleet Corporation. Since the signing of the armistice this programme has been reduced approximately 20 percent.

It developed during the expansion period that it would be possible to produce hulls much faster than the propelling equipment, particularly if Scotch boilers and triple-expansion engines were to be used exclusively. It was, therefore, necessary to place orders for propelling equipment with all shops available, in order to prevent delay in fitting out hulls with propelling machinery after launching.

Emergency Fleet Requirements

As new ship contracts were being constantly made, propelling equipment was ordered in standard units and sizes in large quantities and later allocated to the various shipyards as their needs developed. The necessity for making advance contracts for large amounts of propelling machinery can be realized by the fact that in one day (July

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4, 1918) ninety-five hulls were launched, which required over 250 boilers. Contracts were entered into for all Scotch boilers that could be built in the time available by plants equipped for this work, and contracts were also entered into for new plants and the shop equipment required for the building of additional Scotch boilers; also about 50 percent of the total capacity of the country for the building of watertube boilers was used to produce boilers of this type. A large number of turbines were also ordered to supplement the engine-building capacity of the country. If the original programme of the Emergency Fleet Corporation had not been reduced there would have been a shortage of propelling equipment late in 1919, in spite of the fact that this equipment was ordered in excess of requirements shown by the ship contracts at any period. When the shipbuilding programme was reduced the propelling equipment contracts for these ships were canceled where manufacture had not been too far advanced. In other cases the propelling equipment was completed and stored for future use.

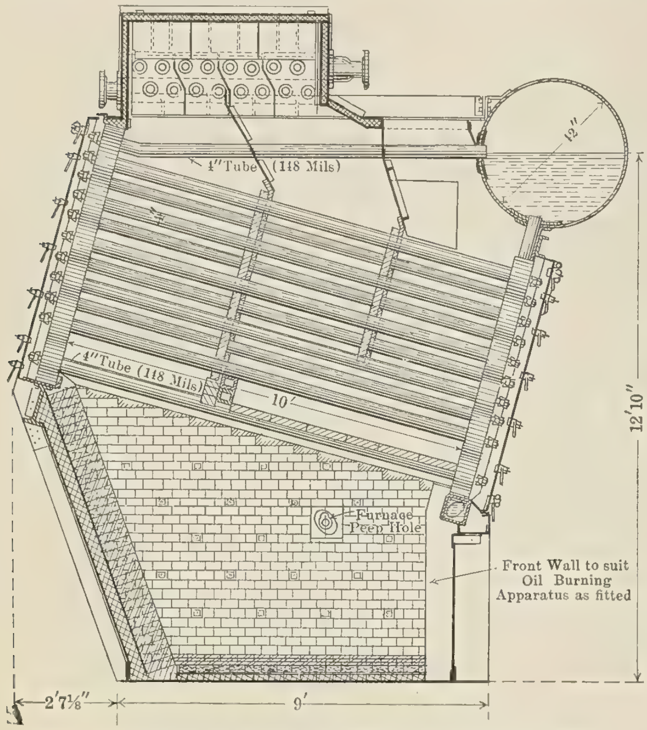


Fig. 2.—Section of Babcock & Wilcox Marine Type Boiler

At the preesnt time the new emergency fleet, including both requisitioned and contract ships, without further cancellations or reinstatement of contracts, when completed will have in service approximately the following boilers:

WATERTUBE BOILERS

Type	Number
Babcock & Wilcox	1,100
Emergency Fleet Standard	600
Foster	450
Heine	185
Badenhausen	65
Yarrow	64
Ward	48
Colvin	32
Scott	30
Wickes	24
Ballin	20
Howden	16
Craig	4
	2,638

SCOTCH MARINE BOILERS

Size	Number
11 feet 0 inches to 11 feet 8 inches diameter	132
12 " 0 " " 12 " 11 " "	46
13 " 0 " " 13 " 11 " "	290
14 " 0 " " 14 " 3 " "	175
14 " 6 " " 14 " 8 " "	231
14 " 9 " " 14 " 11 " "	665
15 " 0 " " 15 " 3 " "	526
15 " 4 " " 15 " 11 " "	150
16 " 1 " " 16 " 6 " "	26
Total boilers, 4,879	2,241

This tabulation shows approximately one-half the ships being built were fitted with Scotch boilers and a similar number with watertube boilers. Scotch boilers are being fitted principally in steel cargo ships and tugs. The designs of Scotch boilers used were prepared by shipbuilders for established shipyards and by the Emergency Fleet Corporation for the new shipyards. All of these boilers are of the more or less conventional design formerly used almost exclusively in merchant marine practice.

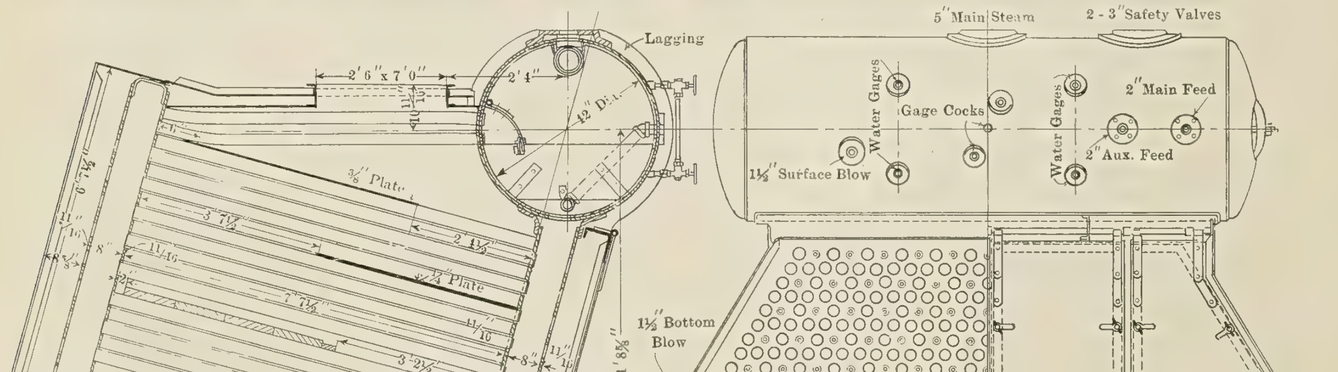


Fig. 3.—General Arrangement of Standard Watertube Boiler for Emergency Fleet Corporation Designed by Technical Department, Washington

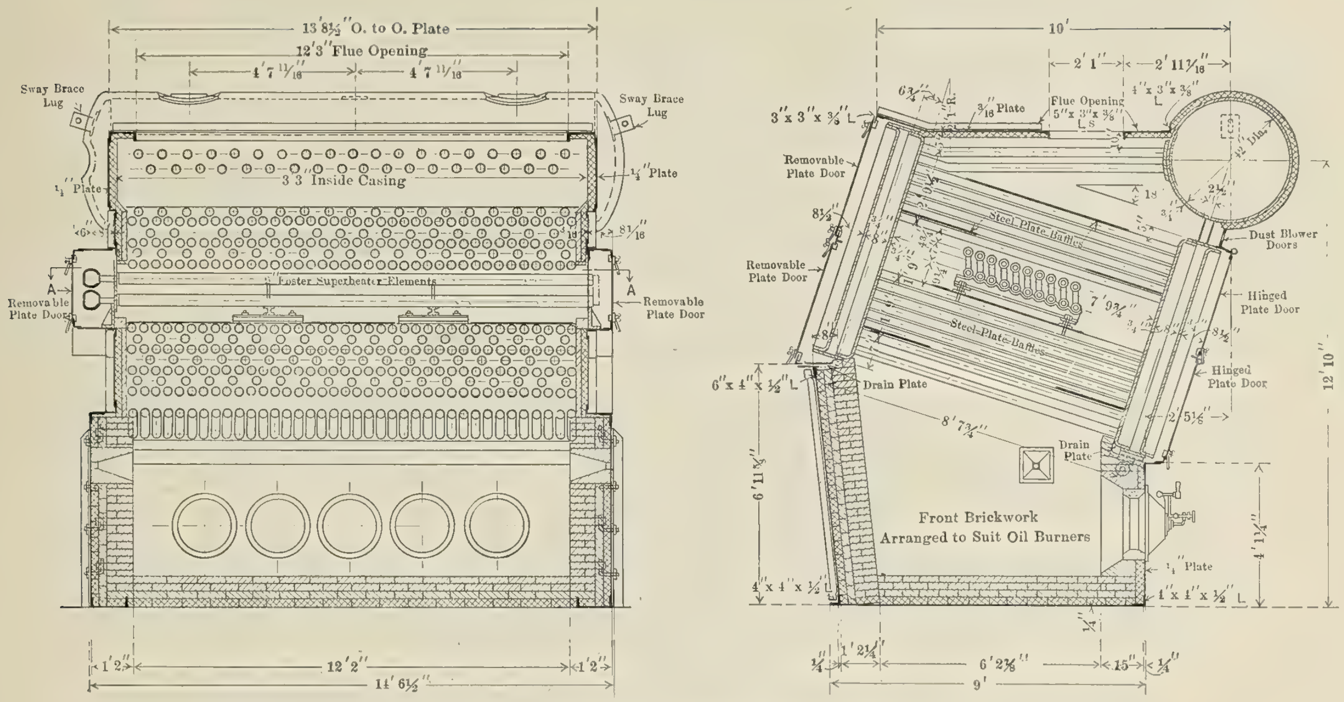


Fig. 4.—Cross-Section of the Foster Marine Boiler

SCOTCH BOILERS

To obtain as economical an arrangement as possible, the Scotch boilers for the emergency fleet were designed to give a ratio of heating surface to indicated horsepower of 3 to 1. For example, a considerable number of standard steel cargo ships were of approximately 8,800 to 9,400 deadweight tons and were equipped with three Scotch boilers built for 210 pounds working pressure, 14 feet 9 inches diameter by 11 feet long, having a total of 8,700 square feet heating surface. These boilers supplied steam to one triple-expansion engine with cylinders 24½ inches, 41½ inches and 72 inches diameter by 48 inches stroke, rated at 2,800 indicated horsepower at 88 revolutions per minute.

The steam consumption of a ship of this type is approximately 45,000 pounds per hour for all purposes. The steam requirements per boiler are therefore 15,000 pounds of steam per hour, equal to an evaporation of slightly more than 5 pounds per square foot heating surface per hour. Under these conditions the average trial trip data of a number of ships showed that the temperature of the gases leaving the boiler averaged 650 degrees F. This was reduced 100 degrees by the waste heat type superheater located in the uptakes above the boiler tubes and further reduced 75 to 100 degrees by the heated forced draft air tubes, giving a final stack temperature of 450 to 475 degrees F. The installation of the waste heat superheater and air heater tubes resulted in giving much greater fuel

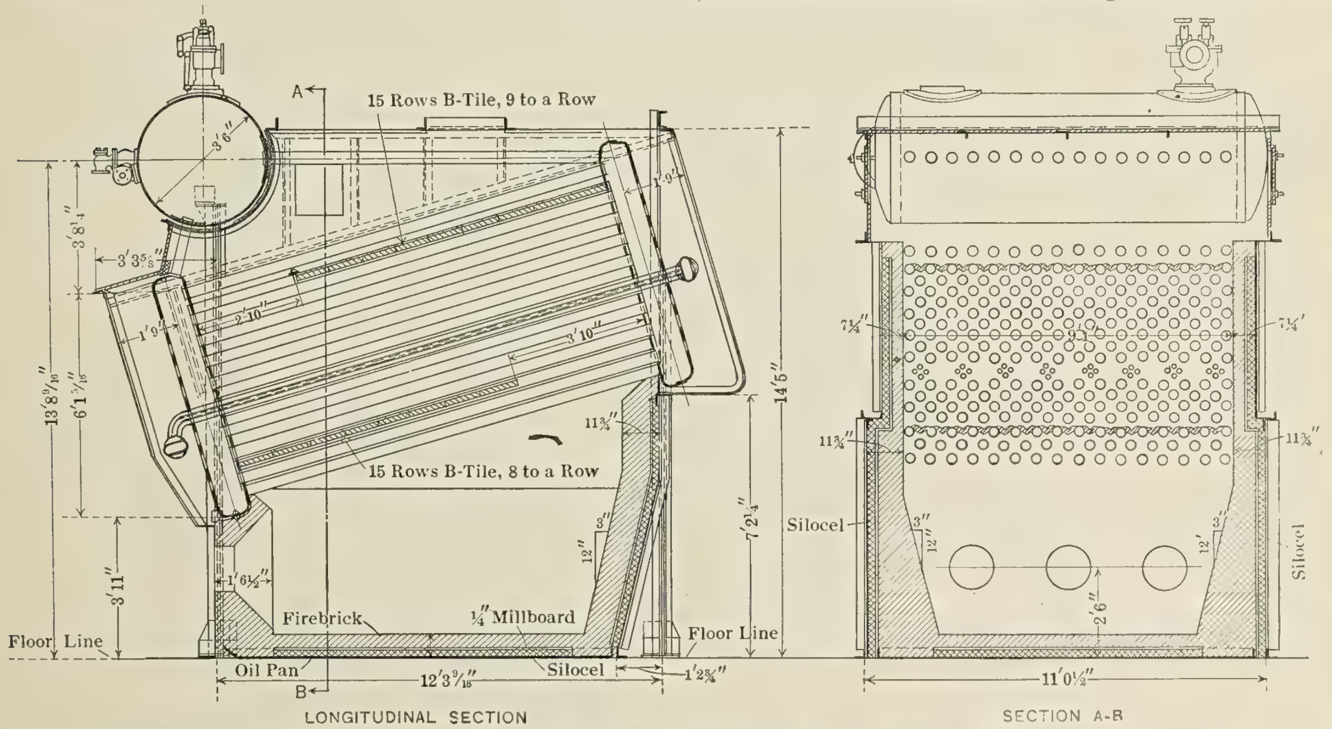


Fig. 5.—Arrangement of Setting for Heine Safety Boiler Built for the Emergency Fleet Corporation. This Boiler Has a Heating Surface of 3,170 Square Feet

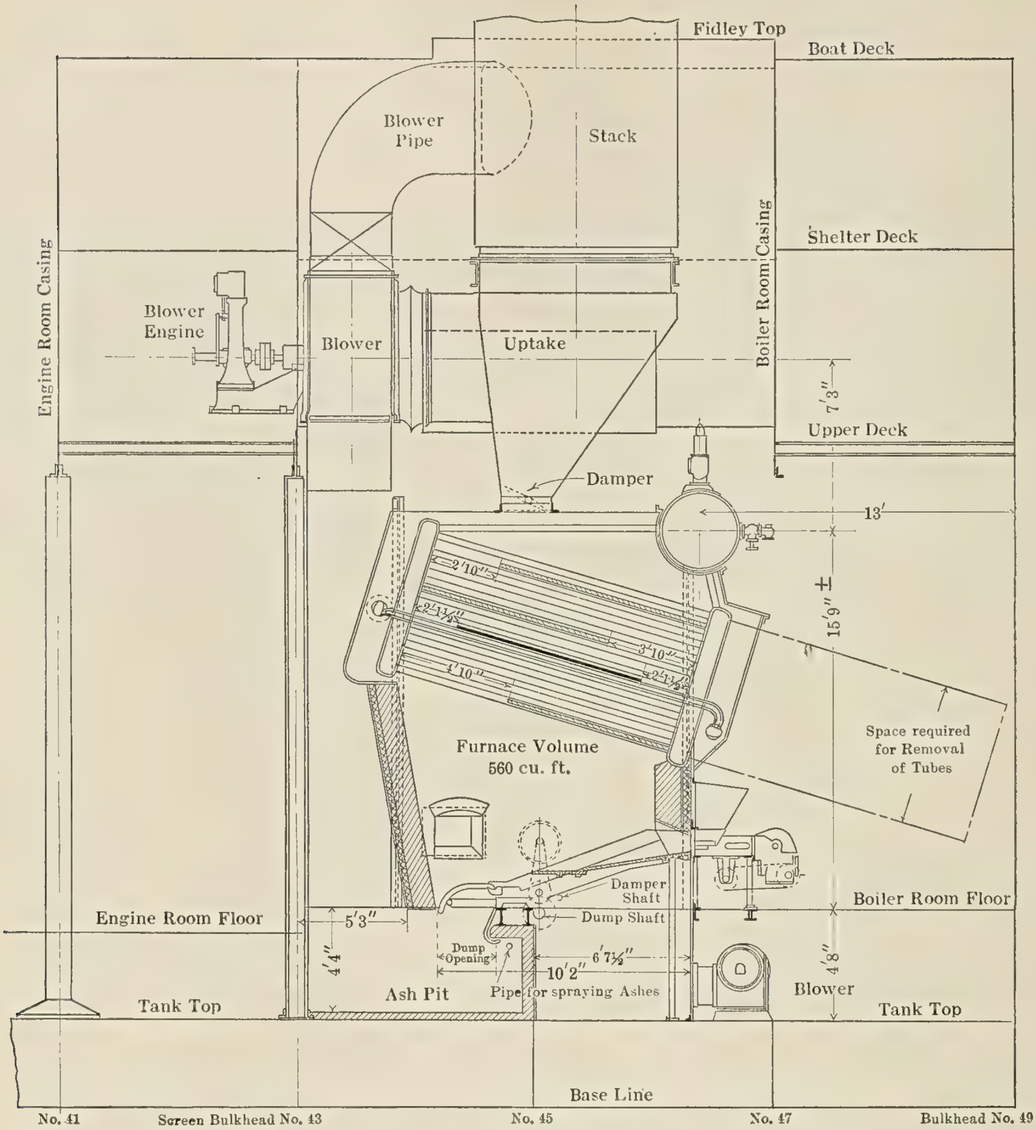


Fig. 6.—Arrangement of Riley Stokers Under Heine Marine Boilers as Contracted for by the United States Shipping Board Emergency Fleet Corporation

economy than was formerly obtained in Scotch marine boilers not fitted with these devices. With this arrangement the economy of the Scotch boiler, its superheater and air heater, closely approximates that of the average watertube boiler.

Weights of Scotch and Watertube Boilers

Ships for the merchant marine are primarily designed to carry cargo, and any unnecessary weight in the propelling equipment reduces the cargo-carrying capacity of the ship. The Scotch boiler is at a serious disadvantage compared with the watertube boiler as regards weight. A comparison of these two types of boilers, both built for 225 pounds working pressure, is as follows:

	Scotch	Watertube
Heating surface.....	2,500 square feet	2,500 square feet
Size of boiler.......	14 feet 6 inches by 11 feet	42-inch cross drum
Weight of metal.....	120,087 pounds	45,991 pounds
Weight of brickwork and baffles.........	....	15,160 pounds
Weight of insulation.	5,364 pounds	840 pounds
Weight of water.....	45,048 pounds	17,000 pounds
Total	170,499 pounds	78,991 pounds

The weight given for the Scotch boiler does not take into consideration the weight of the heated forced-draft system, and superheaters which are necessary for a boiler of this type if reasonable fuel economy is to be obtained or the extra weight of boiler foundations and saddles.

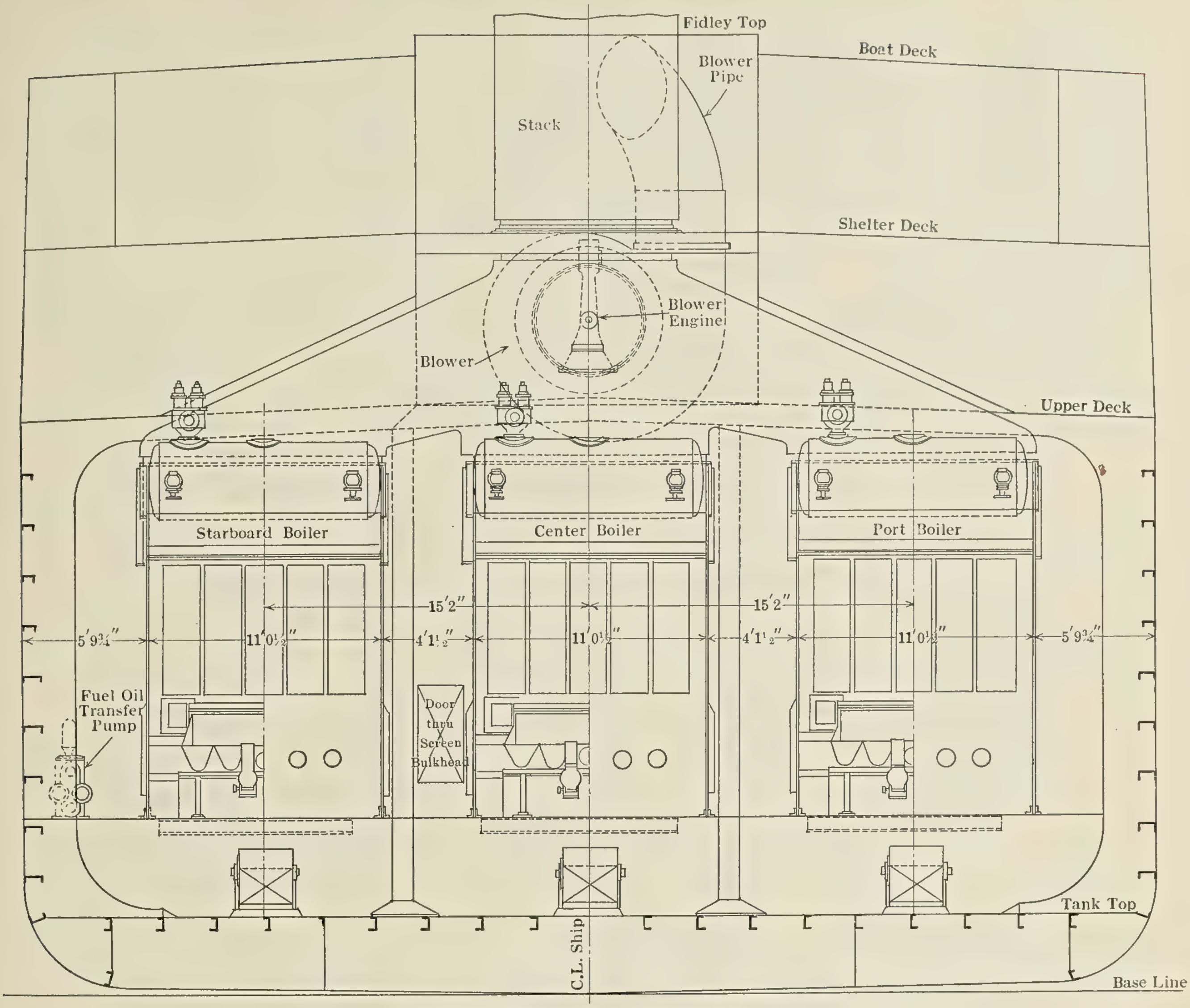
An analysis of the weights of sixty representative Scotch boilers made by different manufacturers shows that this averages from 60 to 70 pounds per square foot heating surface when built for 210 pounds working pressure. The weight of any Scotch marine boiler can be very closely calculated by the following formula:

$$W = \text{diameter}^2 \times L \times P \times .22 \times 1.05 = \text{tons of } 2{,}000 \text{ pounds.}$$

$.22 =$ factor.
$1.05 =$ manufacturers' allowance for overweight of material.
Diameter $=$ inside diameter in feet.
$L =$ overall length in feet.
$P =$ working pressure in pounds per square inch.
$W =$ total weight in tons without water.

The weight of the water in the Scotch boiler is usually more than double the weight of the water in the watertube boiler. This additional weight of water allows a steadier lower level to be carried and gives a larger reserve in case of trouble with feed pumps, but also seriously reduces the weight-carrying capacity of the ship.

The design of Scotch boilers has become so standardized by the rules and regulations of classification societies of the United States Government, and past experience, that all shipbuilders followed closely these rules. This is clearly shown by Table 1, giving in detail the construc-



SECTION AT BULKHEAD No. 49 LOOKING AFT

Fig. 6a.—Section Through Boiler Room of Vessel Equipped with Riley Stokers Under Heine Boilers

tion, pressure, weight, areas, and dimensions of nine Scotch boilers designed by the Emergency Fleet Corporation and five Scotch boilers designed by the leading shipbuilders. Fig. 1 shows a representative Emergency Fleet boiler as used in steel cargo ships. All the designs are for single-ended boilers. The majority of them are of the three-furnace type. It has been found from past experience that double-ended boilers require considerable repairs and are short lived. It is therefore more economical in cargo ships where small power is required to use single-ended Scotch boilers, although this requires additional space in the ship, at a moderate evaporation rate, to secure long life and a minimum of repairs.

Service of the Scotch Boiler

The Scotch marine boiler has, in the past, given satisfactory service, due to its manufacture having been in the hands of experienced shipbuilders and its operation in the hands of experienced marine engineers. When well built, well designed and well operated by a trained crew, with not less than one-third of its area for steam space it will give satisfactory service and will stand a considerable amount of salt feed without priming troubles, but, due to its defective circulation and the different expansion of its various parts at working pressure and temperature, the repairs required are considerable. This is particularly true of ships in the coastwise service on short runs where the boilers are alternately heated and cooled much oftener than on long ocean voyages. In many cases the time required for annual repairs to a ship is governed by the time required for repairs to Scotch boilers, as these boiler repairs require more time than other annual repairs of the ship.

In many cases Scotch boilers at sea when carrying pressures from 180 to 210 pounds have been found with the bottom of the shell at not over 100 degrees F. This is due to the lack of circulation and to the bottom of the boiler not usually being insulated. A great number of devices have been patented and tried out for circulating the water in Scotch boilers, but as none of them has been used for any length of time, it is evident that no successful method of securing the necessary circulation has yet been found.

Due to nearly all merchant ships being fitted with this type of boiler in the past, practically all American and foreign ports were equipped with shops who specialized in the necessary repairs and boiler scaling required when a ship was in port.

Repairs to Scotch Boilers

At the present time a number of Scotch boilers have been installed in the new emergency fleet which are not

TABLE 1.—MAIN PARTICULARS OF SCOTCH BOILERS IN THE EMERGENCY FLEET

Drawing Number	Diameter of Boiler	Length of Boiler	Square In. Working Press.	Length of Grate	Square Ft. Area of Grate	Heating Surface: Tubes	Heating Surface: Furnace	Heating Surface: Com. Cham	Heating Surface: Total		H. S. / G. A.	G. A. / T. A.	Cu. Ft. Volume Steam	Lbs. Weight Wet	Lbs. Weight Dry	Tubes: Stay	Tubes: Common	Tubes: Total
E-15000	15'-3"	11'-3¾"	210	6'-8"	73.	2459 2459	150 270	260 321	2869 3050	Coal Oil	39.3	6.08	480	187490	131740	131-2½"-No.2 B. W. G.	377-2½" No. 10 B. W. G.	508
E-15002	14'-9"	11'-0"	210	5'-6"	60.3	2331 2331	146 262	273 342	2750 2935	Coal Oil	45.5	4.8	380	190126	118930	125-2½"-5/16" Thick	367-2½"- No. 10 B. W. G.	492
E 15003	14'-6"	11'-7 9/16"	210	5'-6"	60.5	2116 2116	152.3 275	260.2 322	2528.5 2713.	Coal Oil	41.8	5.54	419			102-2½"-5/16" Thick	322-2½" No. 10 B. W. G.	424
E-15004	14'-6"	11'-7 9/16"	210	5'-6"	60.5	1952.3 1952.3	152.3 272.3	253.5 315.5	2358.1 2340.1	Coal Oil	39	4.79	407	165900	117500	124-3"-¼" Thick	202-3" No. 10 B. W. G.	326
E-15005	14'-6"	12'-0"	155	6'-3½"	70.78	2121 2121	169 305	234 304	2524 2730	Coal Oil	35.7	5.38	348	141300	94700	82-3"- No. 5 B. W G.	252-3"-No. 10 B. W. G.	334
E-15006	14'-6"	11'-7 9/16"	190	5'-6"	60.5	1951 1951	153 273	254 316	2358 2540	Coal Oil	39	4.8	410			124-3"-¼" Thick	202-3"-No. 11 B. W. G.	326
E-15007	11'-6"	12'-0"	180	6'-5½"	48.3	1241 1241	124 225	157 186	1522 1652	Coal Oil	31.5	6.86	142	105400	68700	40-3"-No. 5 B. W. G.	138-3"- No. 10 B. W. G.	178
E-15008	13'-0"	11'-0"	190	6'-3"	50.	1626 1626	109 200	179 219	1914 2045	Coal Oil	38.3	5.86	312			72-2½"-5/6 Thick	252-2½" No. 11 B. W. G.	324
E-15009	52"	96" High	100	3'-8½"D	10.8	266	67.5		333.5		30.8	4.596	...			2-2"-No. 7 U. S. S.	126-2"- No. 13 U. S. S.	128
Newport News 85878	15'-3"	11'-3¾"	210	6'-8"	73.	2459 2459	150 270	260 321	2869 3060	Coal Oil	39.3	5.66	470			134-2½" No. 2 B. W. G.	374-2½" No. 10 B. W. G.	508
Sun. S. B. Co. 26-862-1	15'-3"	11'-5"	190	5'-6"	61.8	2329.5	164	283.6	2777	Coal	44.9	5.2	445		117756	1 222½"-¼" Thick	341-2½" No. 10 B. W. G.	463
Beth. S. Co. E-1376-35-1	14'-2"	11'-10"	190	5'-0"	55	2050	187	238	2475	Coal	45	5.6	347			110-2½"-5/16" Thick	276-2½"-.120" Thick	386
Newport News 73998	15'-9"	11'-5"	220	5'-4½"	71 2/3	2336	212	352	2900	Coal	40.5	5.43	440	198400	141600	124-2¾"-5/16" Thick	302-2¾"- No. 10 B. W. G.	426
Union I. Wks. 25546	15'-6"	12'-1"	220	6'-0"	67.5	2600 2600	167 300	265 325	3032 3225	Coal Oil	45.	5.08	444	190900	125000	19-5"-¼" Thick 103-2½"-5/16" Thick	339-2½"-No. 9 B. W. G.	361

Drawing Number	Distance Between Tube Sheets	Square Ft. Area Thru Tubes	% of Dia. Top of C.C. from C. of B	Size of Safety Valve	C. of B. to Top of C. C.	Hour Lbs. Water Evap per Sq. Ft. of Grate	Thigness Plate: Shell	Thigness Plate: Front Head	Thigness Plate: Back Head	Thigness Plate: Butt Straps	Furnace: Inside Dia.	Furnace: Outside Dia.	Furnace: Type	Furnace: No.	Furnace: Thick-ness	Furnace: Length	Combustion Chambers: Depth Inside	Combustion Chambers: Greatest Width	Combustion Chambers: Height	Combustion Chambers: Front	Combustion Chambers: Top	Combustion Chambers: Back	Combustion Chambers: Wrap-per
E-15000	7'-4¾"	12.	32	2-3½"	2'-8 3/8"	270	1 11/16"	1 3/16" 1 1/8"	1 3/16" 1 1/8"	1 5/16" 0 1 5/16" 1	3" 3'-8"	4'-0 5/16"	Str. Mouth Morrison	3	21/32"	7'-11 15/16"	2'-11"	C 3'-3½" S 4'-7"	9'-5" 7'-5"	13/16	5/8	11/16	1"
E-15002	7'-2 7/8"	12.49	34	2-3½"	2'-11½"	270	1 5/8"	1 9/32" 1 3/16"	1 9/32" 1 1/16"	1¼"	3'-8"	4'-0 5/16"		3	21/32"	7'-9½"	2'-10"	C 3'-0" S 4'-11"	9'-3" 7'-3"	13/16	11/16	11/16	15/16
E-15003	7'-7½"	10.92	31.07	2-3½"	2'-8¼"	270	1 19/32"	1 1/32"	1 1/32"	1 7/32"													
E-15004	7'-7½"	12.62	30.5	2-3½"	2'-9 3/8"	270	1 19/32"	1 1/32"	1 1/32"	1 7/32"	3'-8"	4'-0 5/16"	.	3	21/32"	8'-2¼"	2'-10"	C 3'-1" S 4'-8"	9'-6" 7'-6"	¾	11/16	¾	15/16
E-15005	8'-1 1/16"	13.17	27.9	4½"	3'-1¾"	180	1 3/16"	1" 7/8"	1" 9/16"	7/8"	3'-8"	4'-0 5/16"		3	21/32"	8'-2¼"	2'-10"	C 7'-8" S 9'-9"	9'-9" 7'-8"	27/32	11/16	¾	11/16
E-15006	7'-7½"	12.6	30.5	2-3½"	2'-9 3/8"	270	1 7/16"	1 1/32" 29/32"	1 1/32" 31/32"	1 1/8"	2'-10"	4'-2 1/16"		3	17/32"	8'-7¼"	2'-10½"	13' 8"	10'-0"	11/16	9/16	9/16	9/16
E-15007	8'-10 5/16"	7.04	25.7	2½" Du.	2'-8¾"	180	1 3/32"	15/16" 7/8"	15/16" 9/16"	13/16"	3'-8"	4'-0 5/16"		3	19/32"	8'-2¼"	2'-10"	C 3'-0¾" S 4'-5 1/8"	9'-9" 7'-8"	13/16	5/8	21/32	7/8
E-15008	7'-8"	8.49	30.7	2-3"	2'-5 3/8"	250	1 5/16"	1 1/16" ¾"	1 1/16" 5/8"	1"	3'-9 7/8"	4' 2 1/16"		2	19/32"	9'-4½"	2'-3½"	5'-1"	7'-3"	11/16	9/16	9/16	9/16
E-15009	54"	2.35	...	2"	....	....	5/16"	7/16"	....	....	4'-0"	4'-4¼"		2	21/32"	8'-3"	2'-3"	5'-4"	7'-6"	11/16	1¾	5/8	13/32
Newport News. 85878	7'-4¾"	12.9	32	....	2' 6 7/8"	....	1 11/16"	1 3/16"	1 3/16"	1 5/16"	3'-9¾"	......	....	..	......	......	......	....	......	..	..	..	...
Sun. S. B. Co. 26-862-1	7'-8¼"	11.9	30	3½" Twin	2'-11 7/8"	270	1 15/32"	1 1/8" 1"	1 1/8" 1"	1 3/16" 0 1 5/16" 1	3'-8"	4'-0 5/16"	Str. Mouth Morrison	3	21/32"	7'-11 3/8"	2'-11"	3'-4" 4'-9"	9'-4" 7'-8"	13/16	5/8	11/16	1"
Beth. S. Co. E-1376-35-1	8'-1½"	9.81	27	3½" Dup.	3'-1¼"	200	1 3/8"	1 1/8" ¾"	1 1/ " ¾"	1¼"	3'-9"	4'-1¼"	"	3	5/8"	8'-3¼"	2'-11"	3'-1" 4'-10"	9'-10" 7'-9"	¾	5/8	¾	15/16
Newport News 73998	7'-7 13/32"	13.2	.285	3½" Twin	3' 4"	235	1 43/64"	1 1/8" 25/32	1 1/8" ¾"	1 9/32" 0 1 19/32" 1	3'-8" 3'-4"	4'-0¼" 3'-8¼"	" "	3 4	5/8" 5/8"	8'-8 5/8" 8'-29/16"	2'-9" 3'-0" 2'-10"	2'-9" 4'-9" C 2'-4" 2 S 4'-3" 2	9'-4" 7'-10½" 9'-10" 2 7'-1" 2	¾ 13/16	5/8 21/32	5/8 21/32	7/8 15/16
Union I. Wks. 25546	8'-2"	13.28	.282	....	3'-4½"	....	1 21/32"	19/22" 15/16"	1 9/32" 15/16"	1¼" 0 1½" 1	3'-9"	4'-1 3/8"	Flanged Morrison	3	11/16"	8'-5 5/8"	2'-11"	C 3'-1" S 5'-3"	10'-1½" 7'-10"	7/8	23/32	23/32	1

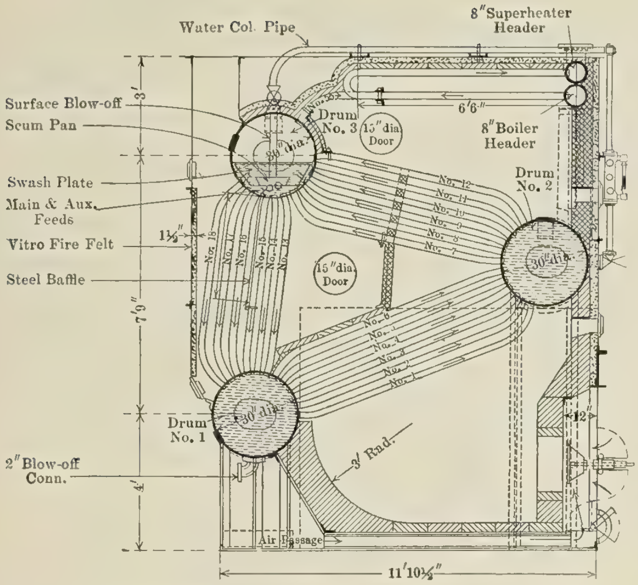


Fig. 7.—Badenhausen Setting, Elevation

operated by trained crews, and in some cases have not been properly built. As a result, repairs to Scotch boilers in these ships have been excessive. Practically 80 percent of the boiler repairs on vessels of the emergency fleet that are now in operation are being made on Scotch boilers, although only 50 percent of the boilers in operation are of this type. In many cases leaks due to poor workmanship of Scotch boilers cannot be made tight by the usual calking, and various kinds of welding have been resorted to. Welding, even when properly done, does not keep seams of Scotch boilers tight more than four or five years, due to the constant movement of these seams. When welding is not properly done it is the source of more trouble than the original leak.

In one recent case an inexperienced crew raised steam in Scotch boilers in less than four hours without circulating the boiler water. As a result the ship was laid up for a considerable length of time to weld and calk the major portion of the shell and combustion-chamber seams. The cost of these repairs on Scotch boilers, coupled with the increased first cost and the short life as compared with watertube boilers, makes the final cost of Scotch boilers for marine use excessive.

In some Scotch boiler designs, principally on requisitioned ships, which were building before the Emergency Fleet took charge, an attempt has been made to install too much heating surface for the diameter of shell used, with the result that the steam space is considerably less than one-third of the total shell area and the boilers, if slightly salted, prime badly. This design also makes it difficult, if not impossible, to scale the furnace crowns and properly clean the other parts of the boiler.

Forcing Scotch Boilers Uneconomical

In some ships an attempt has been made to use Scotch boilers at an evaporation of from 6 to 7 pounds per square foot heating surface. This evaporation can be maintained with oil fuel, but it results in a very uneconomical boiler, due to its extremely high stack temperature. It is also an expensive boiler to operate, due to the repairs required and the very short life of the boiler when operated at this excessive evaporation rate for a boiler of this type. In other cases Scotch boilers have been installed for an evaporation of approximately 4 pounds per square foot heating surface. This, while resulting in an efficient boiler, will give an increased weight of over 200 tons per ship on a 10,000 deadweight ton ship. Its repair cost will be low and its life considerably lengthened, but the increased weight makes it an expensive boiler for the shipowner, due to the space and weight required, resulting in a loss of cargo-carrying capacity.

The majority of the watertube boilers installed in the emergency fleet are of the well-known cross-drum, straight-tube type, which has given successful service both in the navy and merchant marine in the past.

Watertube Boilers

The watertube boilers for the steel ships were principally oil-fired, as it was generally recognized by marine engineers that the watertube boiler is better fitted to withstand oil-firing than the Scotch boiler. Watertube boilers were also almost exclusively used in the wood ships, and were designed for coal-firing, as it was not

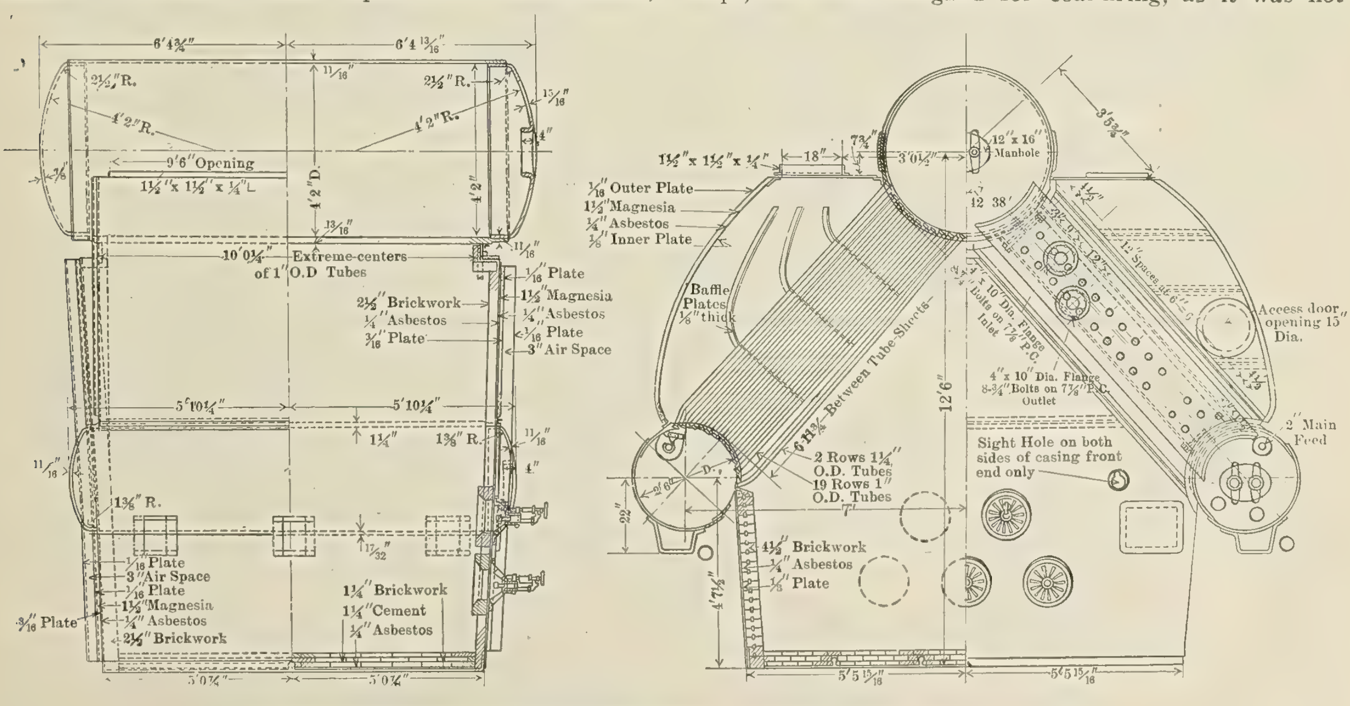


Fig. 8.—Arrangement of Yarrow Boiler Built by Bethlehem Shipbuilding Corporation

considered advisable to make these ships oil burners. The watertube boilers used in the wood ships were of the Emergency Fleet standard design and were built by various manufacturers under the supervision of the Emergency Fleet inspection service.

It was necessary, however, to accept and use in the wood ships a number of other watertube boiler designs which had not been successfully developed for marine practice. Most of these boilers are not satisfactory for marine use.

Babcock and Wilcox Watertube Boiler

The Babcock and Wilcox boiler, Fig. 2, designed especially for use in the Emergency Fleet Corporation cargo ships, is a special large tube design and is a modification of the same boiler as used in land practice. This boiler, while not as efficient as the Babcock and Wilcox standard small tube marine boiler, has a larger furnace volume, larger gas passages, more water storage and is fitted with more than the usual number of oil burners. The result is an easy steaming boiler that can be readily cleaned, and which is more economical than the average Scotch marine boiler.

Emergency Fleet Standard Watertube Boiler

The Emergency Fleet standard watertube boiler was designed to obtain the maximum grate area to enable it to give sufficient steam when operated by inexperienced firemen using poor coal with natural draft. Later, induced draft fans were fitted, but are not used except with very poor coal. This boiler follows the conventional cross-drum marine design. The headers are of staybolted construction with closer tube spacings than were formerly used in marine practice, which, with the four horizontal baffles, has resulted in a satisfactory, economical, as well as a high capacity boiler. Fig. 3 shows the design of this boiler. It will be noted that the rear of grate is fitted with Wager bridge wall, which has proved very successful in practice by allowing excess air at the rear of furnace to assist proper combustion of the furnace gases and in preventing clinkers adhering to the rear brick wall of the furnace.

These boilers are used exclusively in wooden ships, which are generally operated by the younger and more inexperienced engineers. Notwithstanding this handicap, they have in a majority of cases shown remarkable records for reliability and economy, capacity and low cost of repairs. As an evidence of the care these boilers have been compelled to operate under, in two of the wooden ships the boilers have been heavily fired until all the water has been evaporated and the lower tubes melted. In neither case did an explosion occur due to the water having been completely evaporated. These burned-out boilers were replaced by new boilers of the same type.

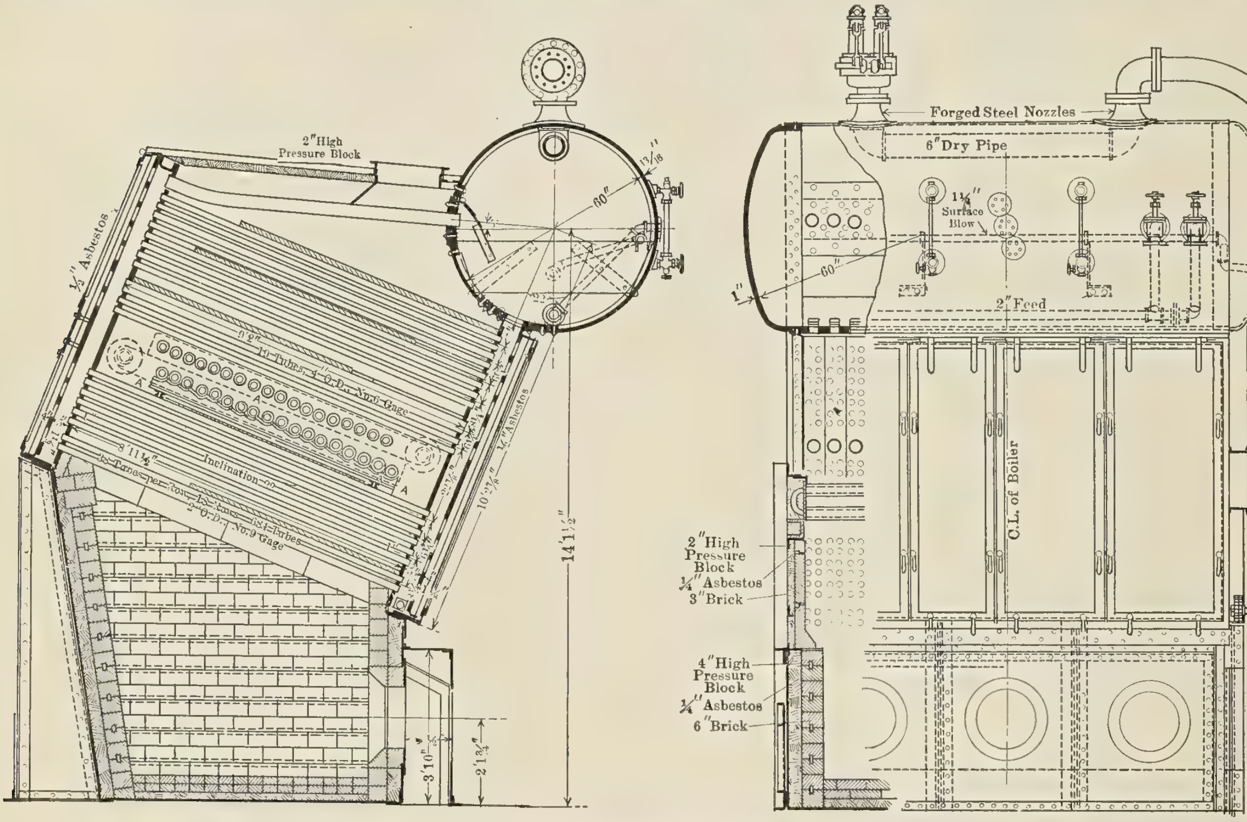


Fig. 9.—Ward Marine Watertube Boiler. Heating Surface, 3,500 Square Feet; Pressure, 300 Pounds per Square Inch

Foster Watertube Boiler

The Foster watertube boiler, Fig. 4, is also of the conventional cross-drum, horizontal, straight-tube type. Its essential features are the close tube spacing, steel baffles and the location of the superheating chamber, which alows any degree of superheat to be obtained that may be required for either marine engines or turbines. The close tube spacing and arrangement of baffles insure the greatest possible economy. The steel baffles are more satisfactory than brick baffles, which have been found difficult to keep tight and therefore need constant repair. The headers are of staybolted construction and have an unusually large capacity for water storage, insuring steadier water level than is usually found in boilers of this type.

Heine Marine Watertube Boiler

The Heine boiler, Fig. 5, is also of the cross-drum, straight-tube type and is a modified form of their land boiler. The tubes are longer than is customary in marine

work, which results in a long, narrow furnace not suitable for coal firing. This narrow furnace, when oil fired, results in considerable furnace brickwork repairs. This boiler, owing to the restricted furnace width, is, however, well adapted to stoker firing. An arrangement of stokers, as shown in Fig. 6, was prepared by the Emergency Fleet for these boilers, but after the armistice, owing to the lower price of oil fuel, nearly all ships were arranged for oil-burning and these stokers were not installed.

Watertube boilers are the only marine type that can be adopted for stoker firing. When the price of coal reaches a point at which it will again be used extensively in marine practice it is evident that stokers of this type or a similar design will be used, as these boilers can then be operated at the same capacity and economy now attained with oil fuel, which is not possible when hand fired by the character of labor available for marine firing.

Badenhausen Boilers

The Badenhausen boiler, Fig. 7, is a distinct departure from the conventional marine watertube boiler, as it uses a large curved tube design with practically no modifications from the land boiler of this type, except the small upper steam drum and steel casing. Boilers of the curved tube type have given very satisfactory operation in land plants and have been used extensively in naval practice, but with tubes of smaller diameters.

Yarrow Express Type Boiler

The Yarrow boiler, Fig. 8, is the well-known express type as used in naval work. The Emergency Fleet ships being fitted with this boiler were originally intended for transports, and will now be used for passenger ships. These boilers are admirably suited for high-powered vessels of this type. No Yarow boilers are being fitted in slow-speed, low-powered cargo boats.

Ward Boilers

The Ward boiler, Fig. 9, is also of the cross-drum, horizontal, straight-tube type. Its essential features are the position and location of the horizontal baffles and the method of manufacturing the headers, which gives the circulation of the sectional header boiler without the use of staybolts. It will be noted that this boiler is fitted with an exceptionally large steam drum, but as the headers are small the amount of water contained in the boiler is not greater than is usually found in boilers of this type.

The Colvin Boiler

The Colvin boiler, Fig. 10, is of the curved-tube, three-drum type, somewhat similar to the express type of boiler, and is fitted with 1½-inch tubes. The essential difference of this boiler from standard designs is the arrangement of baffling with the addition of a steam soot blower. This soot blower enables the operator to keep the tube surfaces clean. Soot blowers are now standard on practically all land boilers, and it is expected that they will be used on all marine boilers in the near future.

The Scott Boiler

The Scott boiler, Fig. 11, is also of the curved-tube, three-drum type. This boiler has little, if any, baffling and depends practically on the tube spacing for its economy. Its casing insulation has not proved sufficient for merchant marine service.

The Wickes Boiler

The Wickes boiler, Fig. 12, is of the cross-drum, horizontal, straight-tube type, with a combination of horizontal and vertical baffles similar to other well-known boilers. Its essential feature is the method of manufacturing the headers, which can be completely machine riveted and have

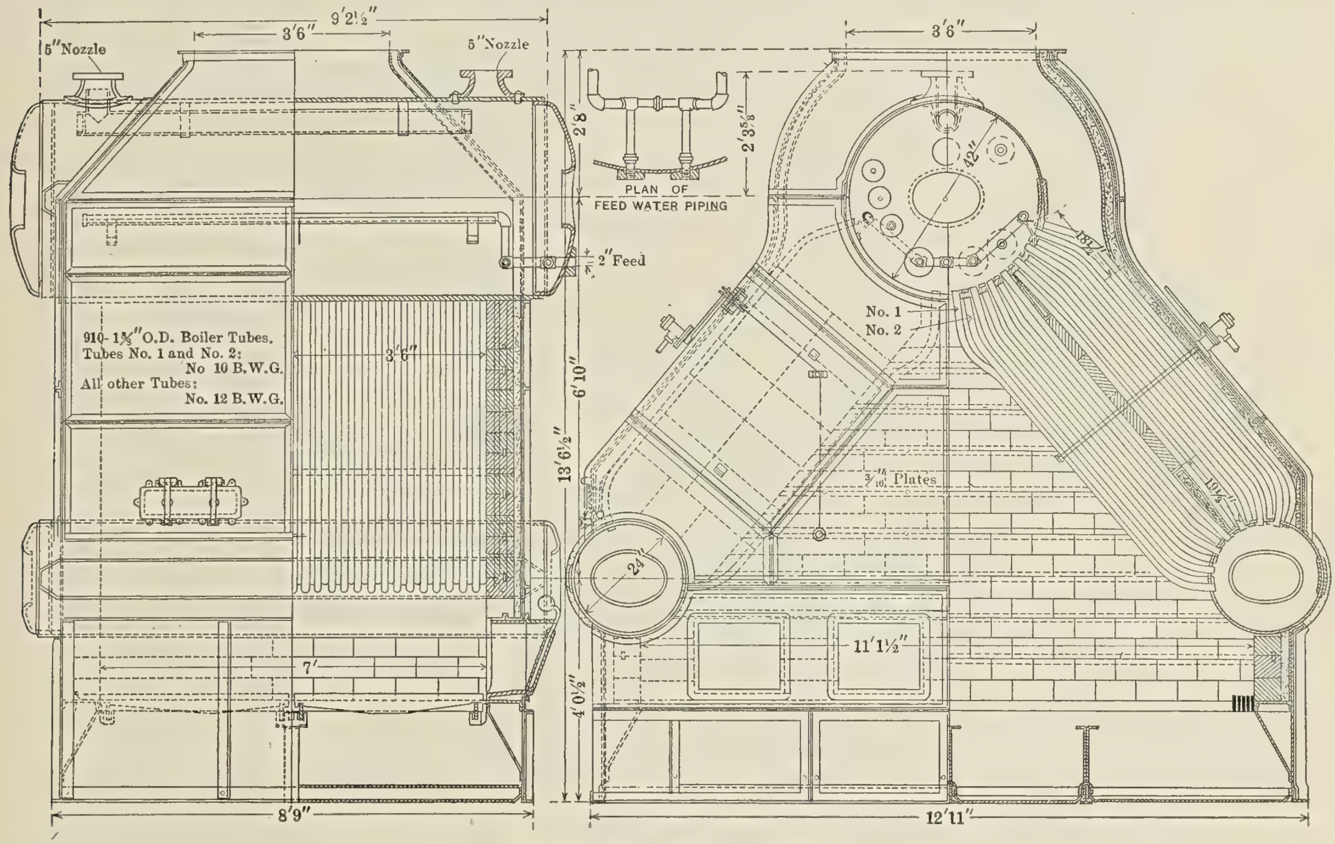


Fig. 10.—Colvin Watertube Boiler

no joints in the fire. This boiler was used on small steel lake vessels exclusively.

Watertube Boilers of Radical Design

The Ballin boiler, Fig. 13, is a radical departure in design from previous successful watertube boilers. It was used on wood and composite types of ships. Its essential features are the long, narow furnaces and the small amount of grate surface for the heating surface installed. The furnace gases do not cover all of the heating surface, resulting in high stack temperatures. This boiler also has a very restricted water circulation. It has not proved satisfactory in service and is being replaced in some cases with Emergency Fleet standard watertube boilers.

The Howden boiler, Fig. 14, is a British type of a radically different design from previous successful marine watertube boilers. Its essential features are the lack of furnace volume, the short gas passage through tubes and the larger lower drum sheet over the fire, where scale deposits and causes rapid burning out of this sheet. This boiler has not proved successful in marine service, especially when oil-fired, and is now being replaced by boilers of the cross-drum, horizontal, straight-tube watertube type.

The Craig boiler, Fig. 15, is also a departure from previous successful marine watertube boilers. Its essential features are the lack of furnace volume and the sectional header construction, using the downflow principle, which was formerly tried out in land practice without success. This boiler was fitted in two ships, neither of which has given satisfactory operation.

Results Obtained with Watertube Boilers

The watertube marine boiler, as shown by the various designs being built and operated by the Emergency Fleet, is capable of being built in a great number of different designs. The most successful watertube boilers in the merchant marine are those of the conventional cross-drum, horizontal, straight-tube type. Boilers of this type built by reliable manufacturers now in service in the Emergency Fleet are giving entire satisfaction as regards reliability, economy, capacity and cost of upkeep. This type of boiler, however, due to the limited water storage and small steam space, requires more careful water tending than the Scotch marine boiler.

With the proper water tending and reasonable care in operation this boiler, when well built, should give satisfactory service for a much longer period of years than the Scotch boiler. Owing to its rapid, well defined circulation it is more likely to prime when salted, due to a leaky condenser or improper operation of the evaporator, than the Scotch boiler, with its larger body of water and defective circulation. If the tubes are kept clean internally there will be practically no boiler repairs excepting the necessary renewal from time to time of the furnace brickwork.

The majority of these boilers are not fitted with sufficient furnace insulation to keep the steel casings reasonably cool. This is a result of trying to adapt naval practice in merchant marine work where weight is not so important. With the proper furnace insulation, such as is installed in the Foster boiler, the furnace steel casing temperatures will not exceed that found with well-insulated Scotch boilers.

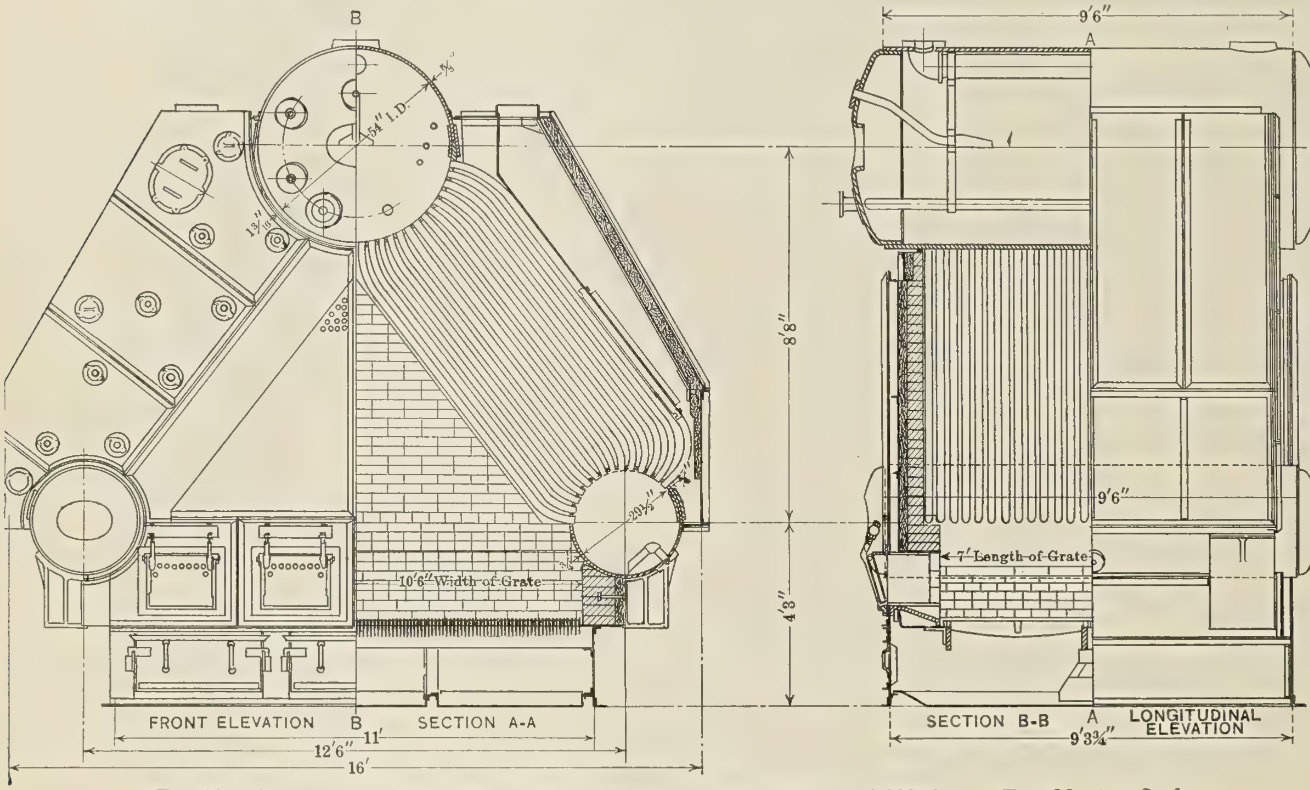


Fig. 11.—Arrangement of Scott Patent Watertube Marine Boiler, Having 3,000 Square Feet Heating Surface

The curved-tube, three-drum watertube boilers are in the majority of cases giving good service. These boilers, however, also suffer from lack of sufficient insulation of the steel casings.

Radical departures from these two standard watertube types have not so far proved satisfactory and in most cases are being replaced by boilers of the cross-drum, horizontal, straight-tube types.

The Engine-Room Force

Engineers for the vast number of new ships are necessarily made up largely of men who formerly did not have any marine experience. A great number of these men

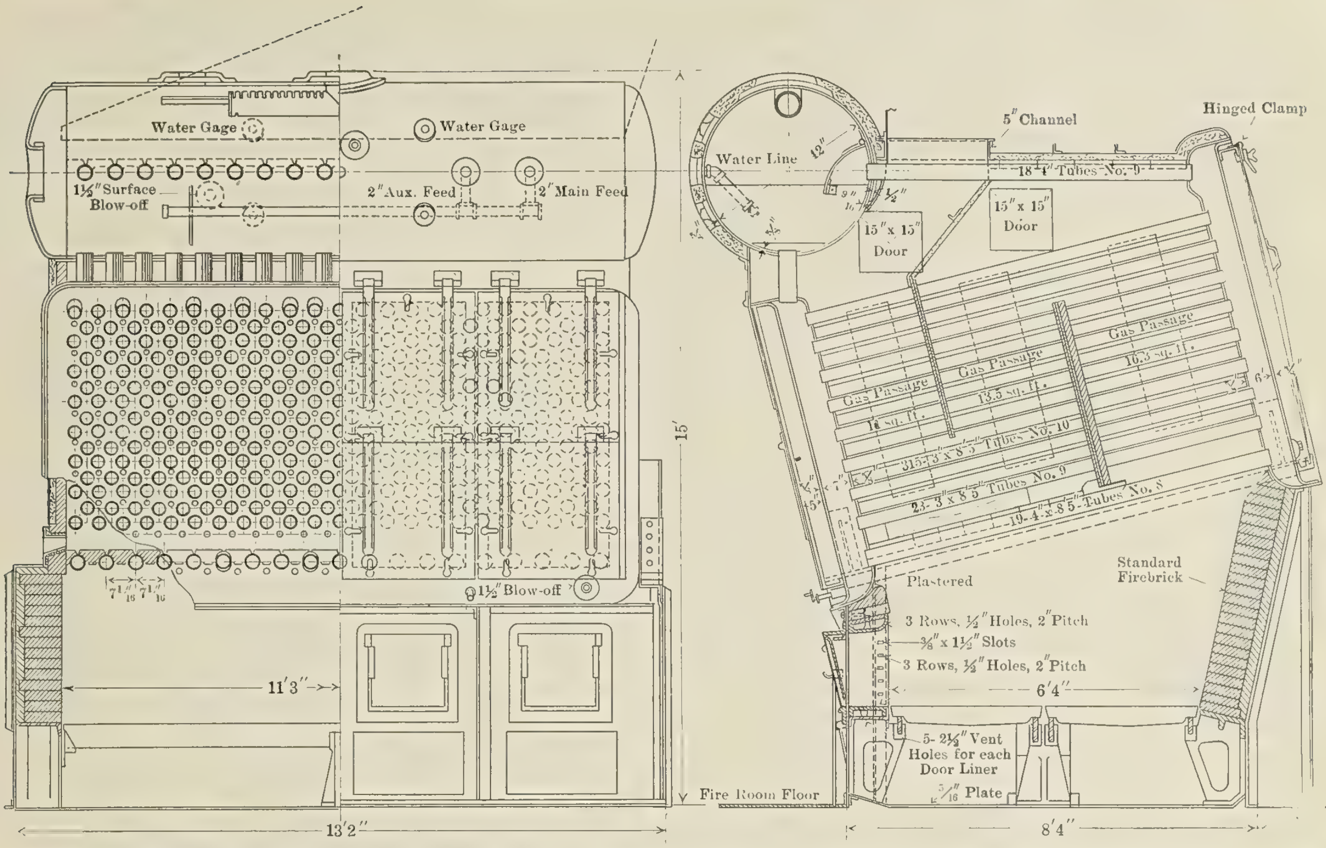


Fig. 12.—Wickes Marine Watertube Boiler. Heating Surface, 2,595 Square Feet; Grate Surface, 69.8 Square Feet; Working Pressure, 200 Pounds per Square Inch

were trained in land plants and are accustomed to operate watertube boilers and turbines under conditions which are more severe on the boiler than those ordinarily found in marine use. In land practice the water very often has large quantities of scale-forming material which deposits in the tubes and the steam demands fluctuate over a considerable range, whereas in marine use the boilers operate under a practically steady steam demand and with good feed water. Therefore, these engineers have had little or no difficulty with the watertube boiler at sea. They have, however, been used to feed water regulators in land plants for watertube boilers, and these regulators will also be used in marine service in the future.

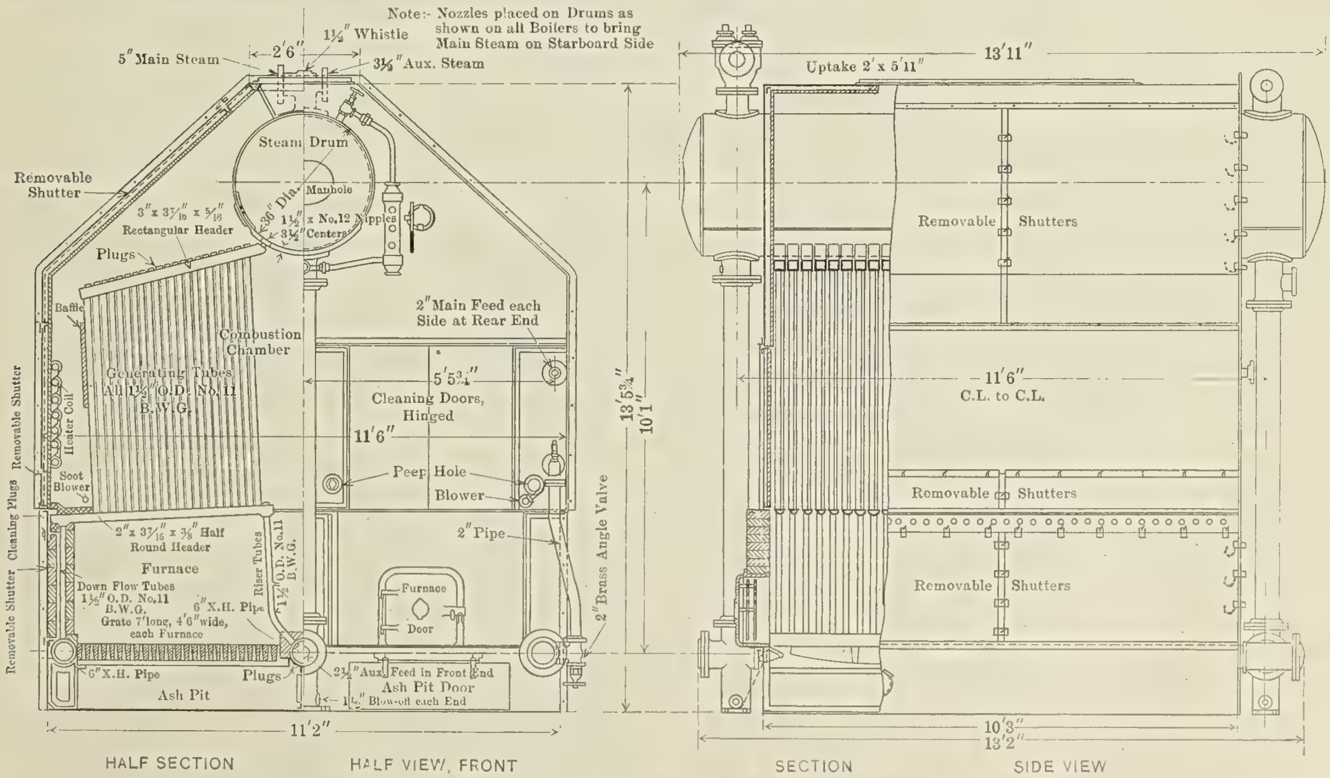


Fig. 13.—Ballin Watertube Boiler Installation Arranged for Use on Vessels of the Emergency Fleet Corporation

There have been a great number of tests made of various types of watertube marine boilers. To date no comparative tests by trained experts and similar test equipment have been made of the Scotch marine boiler, therefore the comparison for economy and capacity of these two types under test conditions is not available. The shipowner, however, is interested in the comparative reliability, economy and capacity of the boilers when operated under marine conditions at sea and not in test conditions for a short period under expert management.

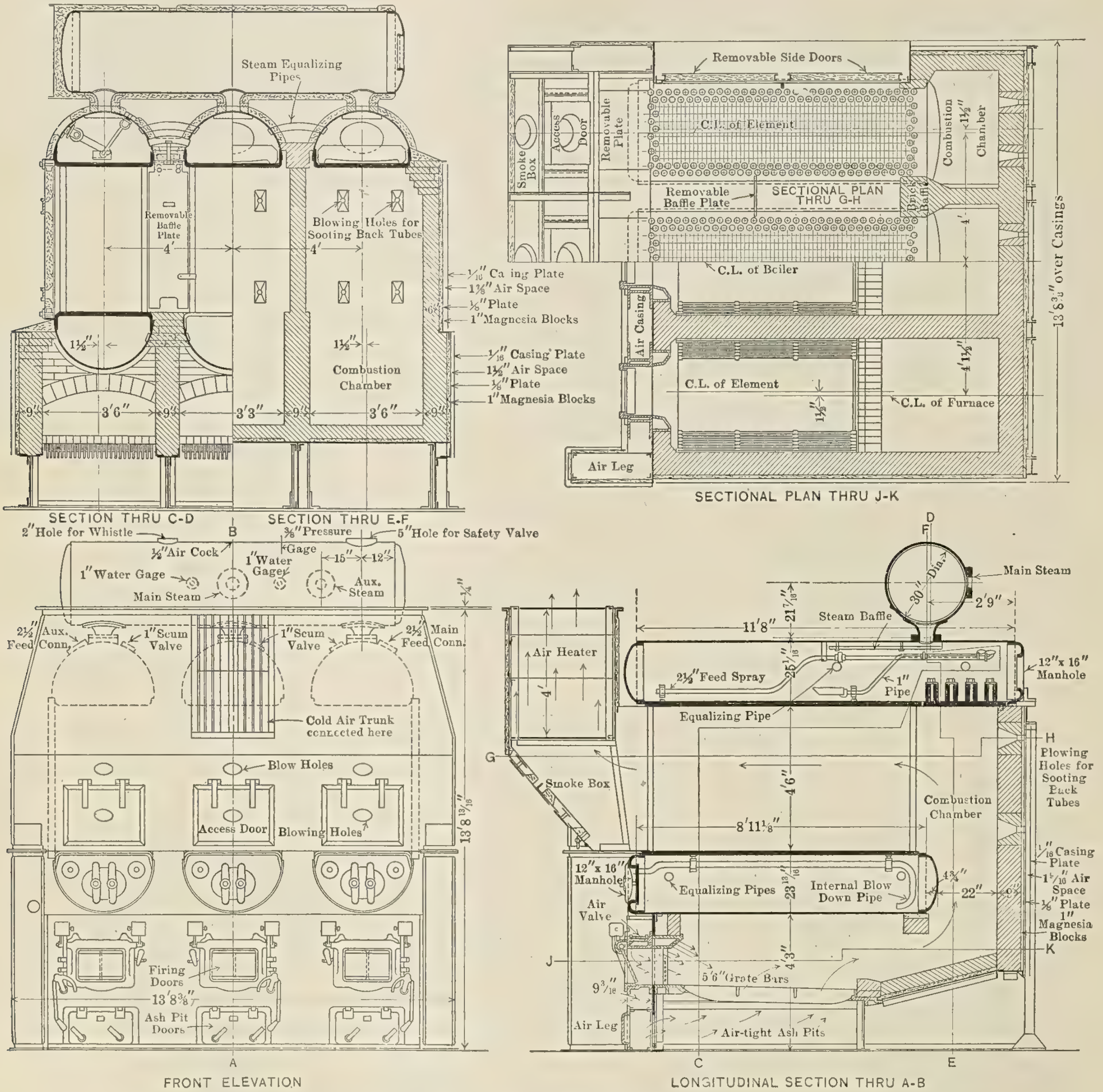


Fig. 14.—Arrangement of Standard Three-Element Marine Type Howden Boiler with Hot Air Forced Draft

Comparative Results

The experience of the various navies and isolated cases in the merchant marine have shown that under similar conditions at sea the watertube boiler is approximately 10 percent more economical in fuel on both short and long voyages. This is due to the longer gas passages, proper arrangement of baffles and larger furnaces for good combustion only possible with the watertube design. The capacity of the watertube boiler, as shown by the navy, is so vastly in excess of the Scotch boiler that no comparison is possible on this point. In recent naval tests a specially prepared express type of watertube boiler has been tested at a capacity of over 22 pounds evaporation per square foot heating surface. It is evident that the requirements of the merchant marine do not call for any capacity that would be detrimental to the reliability, length of life or economy of the watertube boiler. To insure a long life it is customary to operate watertube boilers in the merchant marine at an evaporation of approximately 5 pounds per square foot heating surface.

The repairs on watertube boilers are very much less than those on Scotch boilers and usually consist of fur-

nace brickwork and grate repairs, when burning coal, or furnace brickwork when burning oil. In either case an occasional renewing of the lower row of tubes may be necessary if the boiler is not cleaned internally. All these repairs can be made by the ship's crew. In the case of Scotch boilers the repairs, such as calking, welding and scaling of the boilers internally, are not usually made by the crew, but by outside help.

The first cost of the Scotch boiler for 210 pounds working pressure, not including the necessary heated forced draft equipment and waste heat type superheater required for its economical operation, is, at present priecs, from $9 to $10 per square foot of heating surpace. The first cost of the cross-drum, straight-tube watertube type boiler for 225 pounds working pressure, complete with all fittings, is less than $6 per square foot heating surface. This relative difference in price is approximately the same as the relative difference in weight.

Scotch marine boilers weigh from 60 to 70 pounds per square foot heating surface, and merchant marine watertube boilers from 30 to 40 pounds per square foot heating surface. It is, therefore, evident that the advantages of first cost, weight, economy, capacity and length of life are decidedly in favor of the watertube boiler.

The Scotch marine boiler, however, is well known by the older type of marine men, and is preferred on account of its reliability when properly and carefully operated.

The records of the Emergency Fleet ships, complete to date, show that the watertube boiler is exceeding the Scotch boiler in reliability, and has a lower cost of both upkeep and operation.

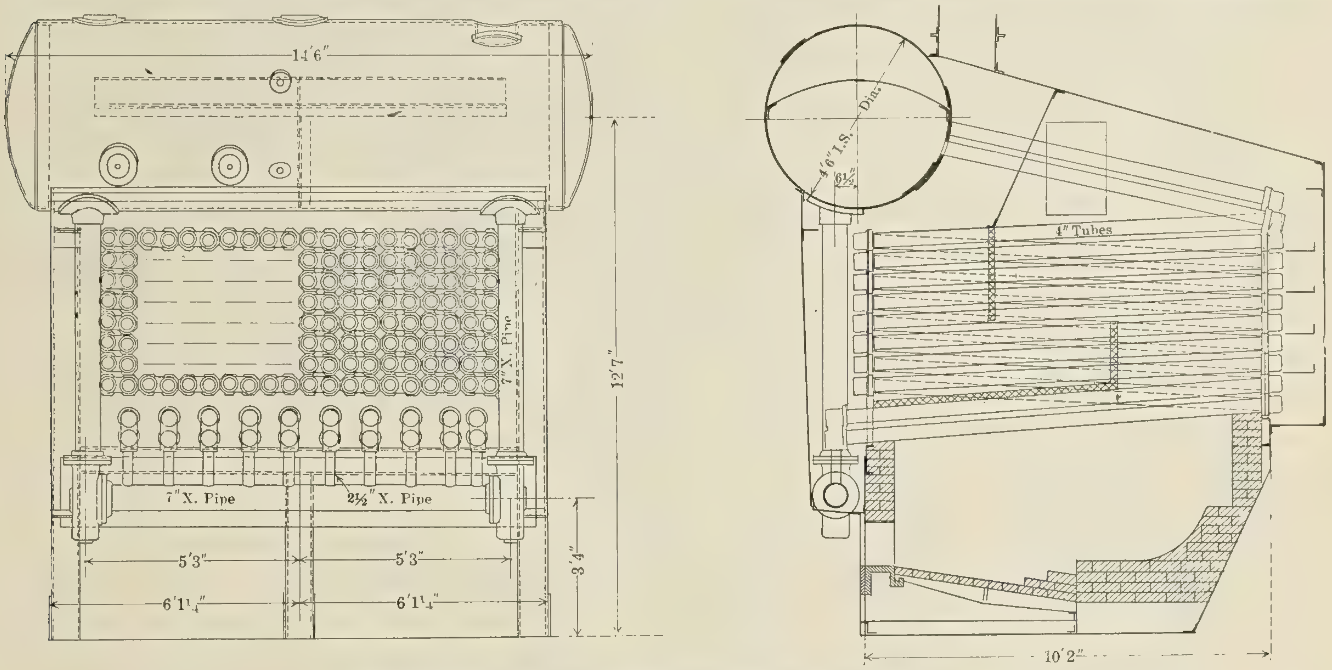


Fig. 15.—Craig Boiler. 2,000 Square Feet Heating Surface

During the next few years, when this record has been more definitely established, it is evident that the merchant marine will follow the navy and use the watertube type of boiler for the major portion of its ships. The Scotch marine boiler will be used, though at a decreasing rate, for a number of years owing to its past record for reliability.

New British Diesel Engine

Fifteen-Hundred Horsepower Diesel Motor Built by Swan Hunter and Wigham Richardson

AMONG the many leading British shipbuilding and engineering firms now producing Diesel engines is Messrs. Swan Hunter and Wigham Richardson, who are perhaps best known as the constructors of the *Mauretania*. Their new engine is of a distinctly novel type, and, although it is based essentially upon the Polar motor of the Atlas Diesel Engine Company of Stockholm, it embodies many entirely new features. It operates on the two-cycle single-acting principle, but instead of having separate scavenging pumps, either driven direct off the crankshaft at the end of the engine or by means of beam levers in front of the motors, there is one scavenging pump for each working cylinder, arranged directly below it and into which air at atmospheric pressure is drawn on the upstroke and compressed to about 3 pounds per square inch on the downstroke. The control of the air admission and its discharge into the scavenging trunk *C* is effected by means of the valve *A*, which is actuated from the camshaft by means of an eccentric and vertical link. From the scavenging trunks *C* and *D*, which act as reservoirs, the scavenging air enters the working cylinders through ports at the bottom when these are uncovered by the piston on its downward stroke, the top of the piston being shaped in a special manner to help in the effective admission of the scavenging air and discharge of the exhaust gases.

The piston valve *A*, in combination with the change valve *B*, serves another important purpose. In most Diesel engines starting is effected by admitting compressed air at 600 or 700 pounds per square inch into the working

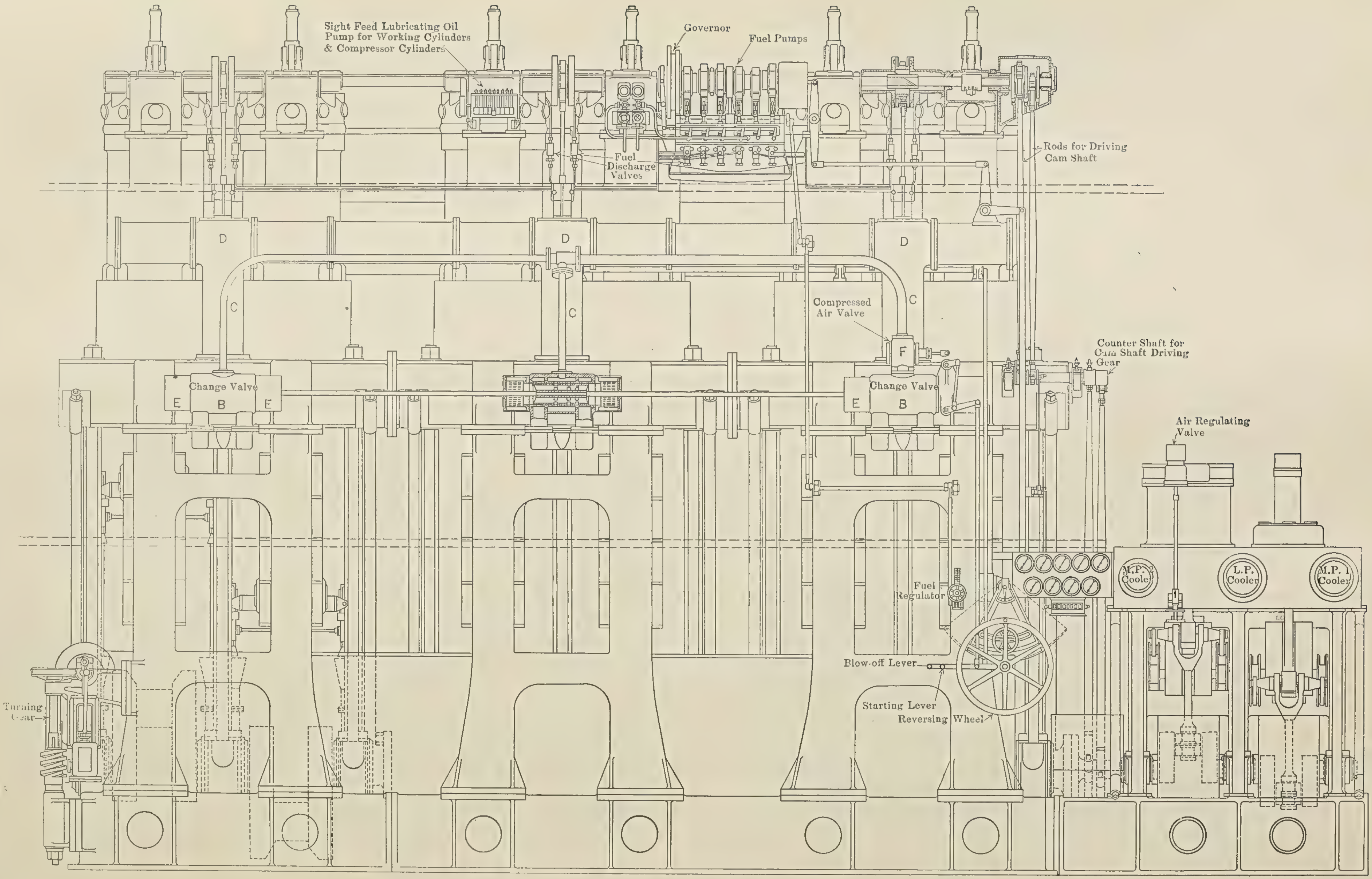


Fig. 1.—General Arrangement of 1,500 Indicated Horsepower Neptune Marine Oil Engine

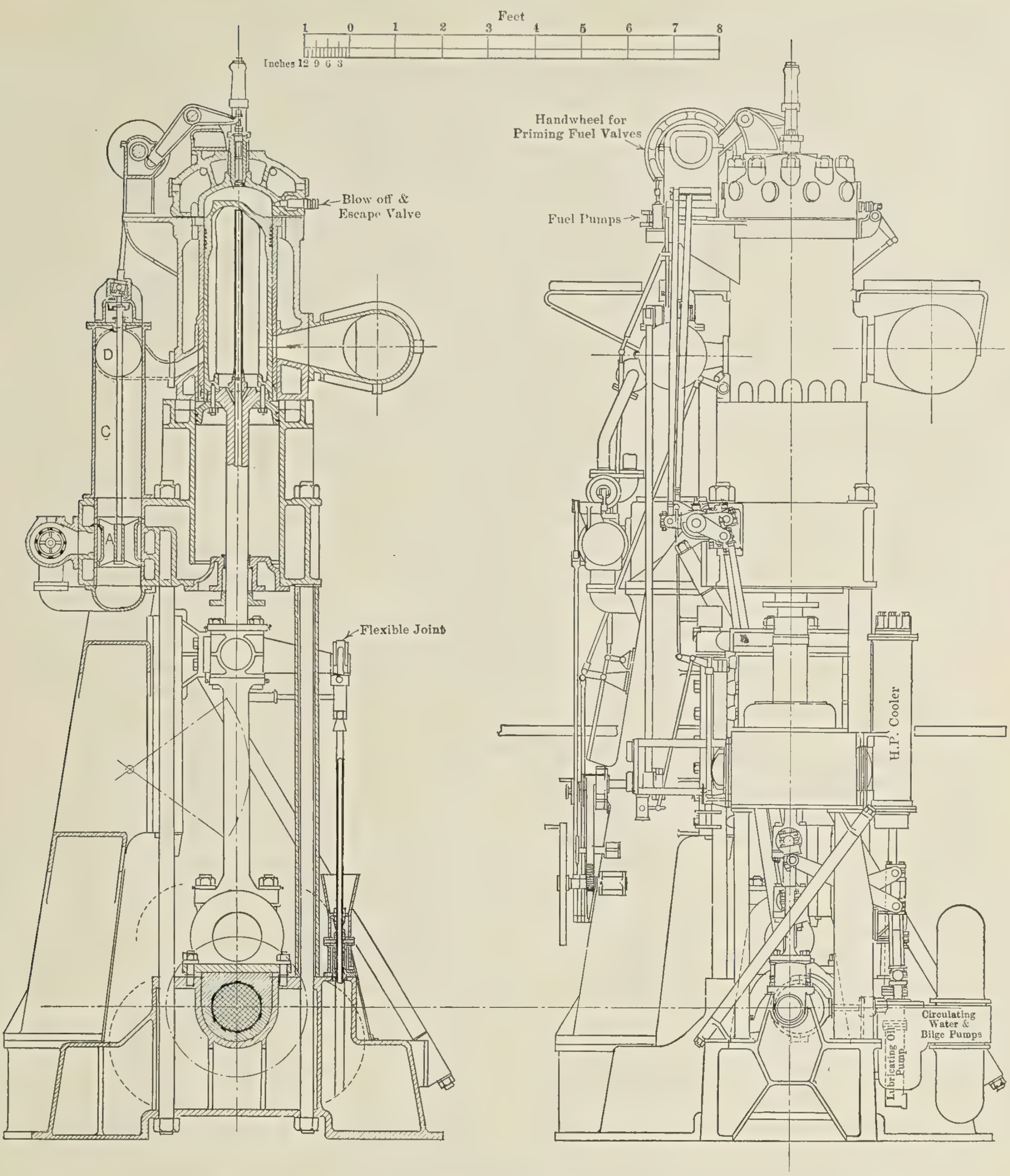


Fig. 2.—Cross-Section and End Elevation of 1,500-Horsepower Neptune Marine Oil Engine

cylinder above the piston, and although this method is generally satisfactory it has the disadvantage that, when the engines are being maneuvered, cold air is supplied to a hot cylinder.

In this new engine the scavenging cylinders are used for starting purposes and compressed air at only 100 to 150 pounds per square inch is admitted below the scavenging piston through the change valve *B* and the piston valve *A*. The object of the change valves can thus be seen. On starting up, these valves are rotated, thus closing the admission pipe to the atmosphere and opening it to the compressed air supply, so that now compressed air passes through the piston valve *A* into the scavenging cylinders instead of atmospheric air, which enters in the normal course of operation. These change valves are of the rotary type and are operated by means of a lever from the control station, so that on starting up compressed air is admitted until the engine fires, after which the valves are immediately changed over to allow air to be drawn into the scavenging cylinders from the atmosphere.

As the working cylinders are scavenged by means of ports, only one valve is required in each cylinder cover, which is for the admission of fuel. This is operated from cams on a camshaft driven from the crankshaft by long eccentric rods and a countershaft. When reversing an axial motion is given to the camshaft by means of the reversing wheel, thus bringing the rollers of the valve levers under the astern cam instead of the ahead cam. In order to provide easy starting and to allow of running at low speed, half compression cams are provided, both ahead and astern.

Some of the details of construction are unusual. The scavenging cylinders are supported on cast iron columns at the front and by vertical steel columns at the back, while the arrangement of diagonal columns to provide stiffness will be noted in the illustration. A pair of columns carries a pair of cylinders, and by this construction the engine can readily be standardized in four-, six-

and eight-cylinder models. The cylinder liners are cast separately from the jacket or from the cylinder covers, so that in the event of a liner cracking it is only necessary to replace this part and not a complete cylinder, which would be necessary if the jacket and liner were cast in one, as is sometimes carried out in Diesel engine manufacture. The air compressor, which is driven from two cranks, forming an extension of the crankshaft, is of the four-stage single-acting type, with the usual inter-coolers, and with the exception of the high-pressure stage the cylinder liners are cast with the jackets. The circulating water and bilge pumps are of the plunger type, arranged at the back of the compressor, driven from levers, and sea water is supplied to the piston for cooling, passing right to the top of the piston through the pipe shown in the illustration and discharged at the bottom through the hollow piston rod.

The fuel is supplied to the fuel valves from six separate pumps, which are bunched together in the middle of the engine and are driven from the camshaft. The usual method of controlling the amount of fuel, and therefore the speed of the engine is adopted.

The engine, of which illustrations are given, is a six-cylinder model developing 1,500 indicated horsepower at 115 revolutions per minute, having a cylinder diameter of 18 inches and a stroke of about 3 feet.

Inland Waterways of France

Interesting sidelights on the French inland waterways have been furnished to us by Captain J. Murray Watts, U. S. A., who has just returned from France. Here he commanded Company E of the 57th Engineers, the inland waterways regiment which was scattered in detachments all along the rivers and at the ports of France. One section from Company E, under Lieutenant Hickey, U. S. A., was employed at Brest during the greater part of the war in the construction and repair of lighters. At this port, owing to the small number of docks, steam lighters and tugs were kept busy day and night in bringing men and ammunition ashore. Another detachment built and operated a shipyard at St. Nazaire, where twelve lighters were built from local material and a large number of tugs were rebuilt and repaired.

OWING to the congestion of the French railways during the war, a large amount of bulk freight was carried by river steamers, power barges, steam tugs and lighters to certain stations which served as central distributing points. The canal system is so extensively developed in France that it is possible to take a barge from Bordeaux on the Atlantic coast through to Cette on the Mediterranean by canalized rivers and canals. The extent of the French canals may be realized from the following incident. On one occasion Captain Watts was ordered to inspect some small river tugs at Montauban, a town situated about half way between Bordeaux and Cette. He subsequently took one of these boats, upon which repairs could be made, down the Garonne river to Bordeaux, thence by the Bay of Biscay up the Loire river to Camp Gron at Montoir, where a shoal draft tug was needed in building a new dock. This structure, by the way, was nearly a mile long and extended out into the deep water of the Loire river in the form of the letter L.

A large number of these French canals were planned by Napoleon. In fact, many of them run parallel to the great system of military roads or Routes Nationales. Often these roads are built in three strips along the banks of the canals—one section of grass for the cavalry, the middle section of macadam for the infantry and light automobiles, and the third section of granite blocks for the artillery and heavy trucks. By this arrangement freight can be loaded onto the trucks from barges at points convenient for distribution. Instead of having the railroads and inland waterway systems antagonistic, as is often the case in America, the French canals carry the bulky freight, leaving the higher-priced fast freight for the railways, to their mutual advantage.

Traffic on the Seine river from Havre to Paris and from Paris through the canalized portion of the Marne to Chateau-Thierry and Dormans is thoroughly practical. On the Loire, from St. Nazaire to Nantes, good-sized steamers can be employed to advantage. Above Nantes, as far as Tours, the traffic is handled by barges.

The type of river barge favored in France and Belgium is a steel boat about 164 feet long with a heavy duty oil engine in the stern, and an additional small oil engine for handling the winches. Owing to the destruction of the coal mines in northern France by the Germans, the cost of coal is very high. Consequently the use of crude oil engines is particularly advantageous, since crude oil can be obtained from Holland at a price which proves satisfactory when the relative economies of the oil and the steam plants are compared.

The accompanying photographs show some of the smaller steam tugs and inspection boats used in the inland waterway service. A number of barges and tugs using gasoline (petrol) for fuel are employed.

Some of the more up-to-date barges have electrical plants and operate their winches by electrical motors. Rather large propellers and medium speed motors are used because the French rivers, while not appearing very large on the map, are quite deep and the current generally runs from 1¾ to 3 miles per hour. After the armistice was signed considerable traffic was handled on the Rhine between Antwerp and Coblenz by motor barges.

The locks and gates of the more modern canals are equipped with up-to-date machinery. However, the greater number of locks and gates are operated by the old-fashioned hand control. During the war these were operated by young girls and the older peasant men. It was found advisable to obtain permits for the American engineering crews stationed on river boats to be allowed to operate these locks. This arrangement resulted in a great saving of time.

Working in conference with the French engineers after the armistice, Captain Watts, as liaison officer, became familiar with future plans for the development of French waterways. The Department des Ponts et Chausses, which is in charge of the Government bridges, docks and canals throughout France, plans to increase greatly the capacity and number of canals to accommodate after-the-war traffic.

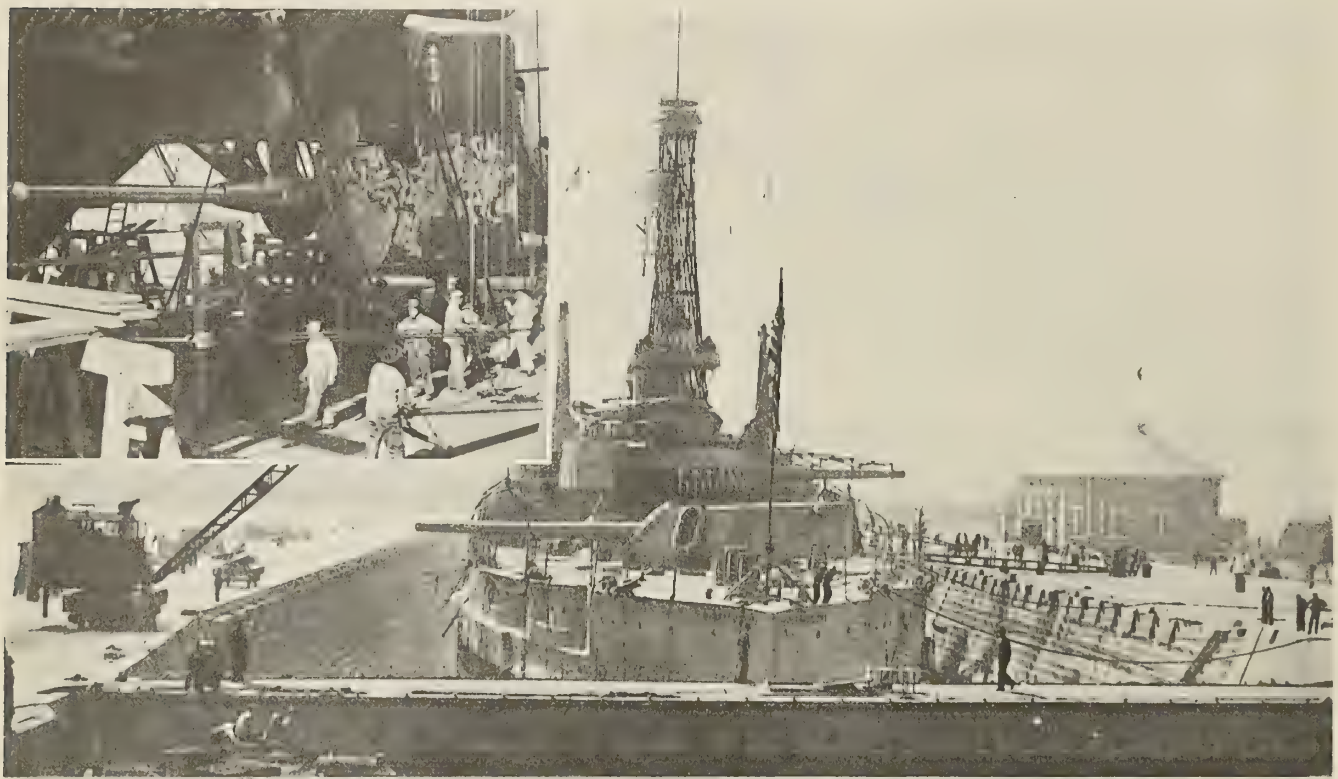
Charlot, the Small Steam Work-Boat Used in the Canal "du Midi" at Montauban

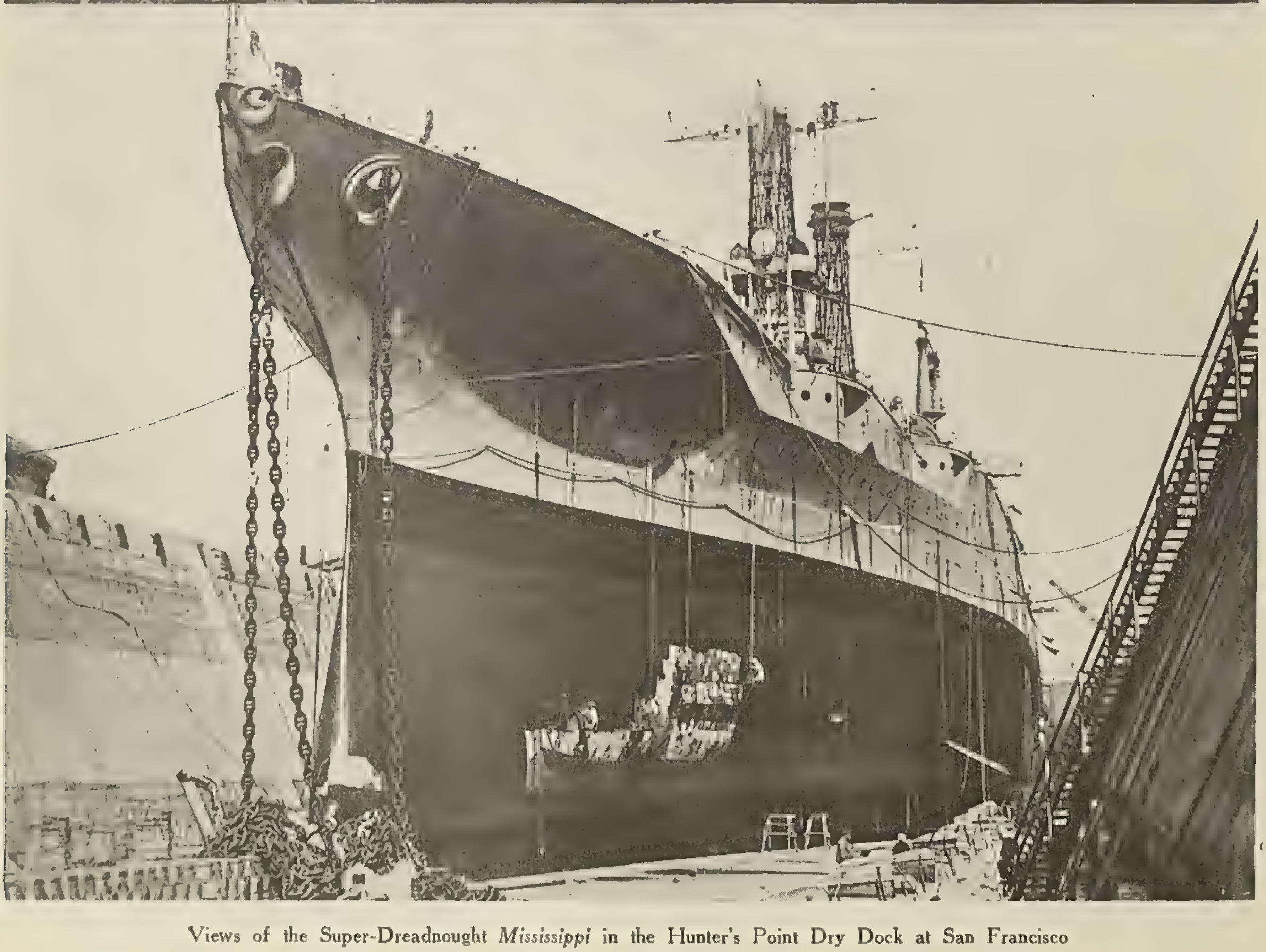
The Tug *Yvette*, Which Was Used by the American Government at Bordeaux

Suzanne, the Shallow Draft Tug Which Captain Watts Brought Down from Montauban on the Garonne to the Engineers at Camp Gron on the Loire

United States Battleship Mississippi

(Photographs Copyright by International Film Service, Inc., N. Y.)





Views of the Super-Dreadnought *Mississippi* in the Hunter's Point Dry Dock at San Francisco

"Economy Rampant"

The Amazing Career of a New Steamship Manager—His Struggle with the Coal Barons and the Final Reckoning

BY A WELL-KNOWN STEAMSHIP OPERATOR

THE first set of books that I acquired by purchase consisted of a very beautiful special edition (printed exclusively for early subscribers) of the *Encyclopedia Britannica.* Sample copies of its pages and of its elegant binding (accompanied by terms of subscription and the inevitable contract) were submitted to me by one of the typical old-time book agents, who assured me, as he took the "five-dollars-down" first payment, that I might consider myself to be thereafter among the comparatively favored few who could boast of possessing and having at his fingers' ends all that was worth while knowing in this world. This happened many years before the advent of Dr. Eliot's five-foot shelf.

I was eager to acquire knowledge, and I set myself to the pleasant, though arduous, task of giving an hour daily to my new-found friend, the encyclopædia. For ready convenience I had built for my books a set of shelves that fitted in a niche of my room. Years later, when a lighter edition appeared, I made a present of my early literary venture to a friend, and the books, which had reposed serenely on their shelves, untouched and unsullied, had to be removed practically by using cold chisels and mallets, so compactly and homogeneously had the beautiful leather volumes stuck to each other in close and undisturbed companionship.

It was thus that I became educated, and it is for this reason that I have always had a soft spot in my heart for book agents. Book agents, like life insurance brokers, are, I think, blessings in disguise and worthy of greater consideration than we usually accord to them; because, were it not for their importunities, we would be uneducated, unread and unpolished, and likewise unprotected against the uncertainties of life. Book and life insurance agents filled my office and my home and drew from my income for years, forcing me to lay up for assessments and premiums what I might otherwise have spent for sailing yachts, cigarettes, automobiles and other luxuries.

It was my faith in these perambulating dispensers of education and protection to my estate against premature death that made me an easy prey to the wiles of their cousins in the trade: the old-type canvassers, or drummers, of just American fame.

My First Experience in Steamship Management

I had graduated from the accounting department of the organization in which I served and had been given an opportunity to show what talents I possessed to manage the operating branch of our industry, when my experiences began. My first visitor was a dapper young fellow who represented a manufacturer of anti-corrosive and anti-fouling compositions. He was a chap of unusually fine appearance, and he used the very choicest of words, which flowed through his lips like an unimpeded torrent of water in a spring flood.

"Far be it from me," he began, "to run down the excellent product that some competitor may be furnishing to you. But whatever composition you use—whatever you pay for it—I am certain that I can more than satisfy your needs if you will give our compositions a fair trial."

"But," I asked, "if the article which we are now using is giving satisfaction and the price is right, why should I change?"

"Because," he quickly retorted, "our compositions are made after a secret formula, the result of many years of research. They are absolutely inpervious to marine growths. The smoothness of the ships' bottoms when covered with our products will be such that I guarantee you a saving of at least 15 percent in your coal bill."

"But what has coal consumed in our ships to do with the paint that is applied to their exterior?"

"The resistance," he answered, "of a ship's mass as it is propelled through the water is greatly lessened by the use of our preparations because neither marine grass, nor barnacles, nor the hitherto inevitable slime that adhere to ships' plates under water can possibly grow or develop. Other compounds in the market do not give this protection, hence you are pushing an unnecessary quantity of foreign and injurious matter through the water. By eliminating these parisitical formations you save power; by saving power you save steam; and by saving steam you save fuel; and the exhaustive tests that we have made show that this saving varies between 10 and 15 percent."

The convincing voice and earnestness of manner made me capitulate.

Coal Requisition Reduced 15 Percent

That day I made an entry in my record book and issued orders to our marine superintendent to reduce our requisitions for coal to the extent of 15 percent. As our coal requirements were two hundred thousand tons annually and the price \$3.50 (14/7) per ton, I noted in my little book a saving to my company of \$105,000 (£21,600) per year, and, figuratively speaking, patted myself on the back and sallied forth well satisfied with a good day's work.

My next visitor from the fraternity of canvassers was a brawn, heavy, middle-aged man, who spoke with a decided Scotch brogue.

Sherlock Holmes would have at once proclaimed him a Scot—and so he proved to be—and, of course, being a Scot (a "canny" one at that), I guessed him to be a retired ship engneer, and my guess turned out to be an accurate one.

He offered me a cigar, which, like all the cigars in all the tales that I have ever read, was long and black. I declined to take it, whereupon he laughingly remarked that he did not wonder at my refusal to accept his tender, as no doubt with the oportunities at my command—operating ships to the land of nicotine—I could readily and abundantly supply my needs and those of my weed-loving friends without having to pay to Uncle Sam the iniquitous tribute that the United States customs laws exacted.

I begun at once to distrust my visitor, but as he unfolded certain blueprints and statistical tables before me to illustrate the wonderful apparatus that, under royal patents, he was installing in many vessels' boilers to improve and normalize their circulation, I became interested, and I entered into the proposition that lay before be, forgetting at once all about his objectionable personality and insinuatingly insulting remarks.

The device which he sought to sell or rent to us would, he claimed, prevent a fault common with marine boilers that were not provided with his device. Instead of carrying water at varying degrees of temperature, due to stagnation and other causes, it would, induced by his patent machine, remain constant; steam would generate more readily and evenly; power would increase and the saving in fuel as a result of these changed conditions would, he assured me, reach anywhere from 10 to 15 percent, as proved by tests made in a large number of ocean-going vessels; so many ships, in fact, that upon my asking him for the name of one single vessel that might serve me as a convincing guide, he could not mention it—so many names, no doubt, having confused him.

Another 15 Percent Fuel Saving Promised

I insisted, however on being told the name of at least one ship that carried a circulator, and was informed by my visitor (not without some reluctance) that the high-pressure tug *Puffing Billy,* built in 1837, engaged in towing barges from Gowanus Creek to Barren Island, was being successfully operated with one of the wonderful circulators, and that her captain-owner, Mike O'Flarety, would be glad to testify to the worth of the apparatus.

Now, with 15 percent of coal already saved by using my friend's compositions, why not add to the lustre of my business career, so auspiciously opening before me, by showing my president and board of directors that I could save another 15 percent at a paltry additional cost of a few hundred dollars to install the ingenious Scotch circulators in the boilers of our ships?

I signed the contract and jotted down in my book an entry showing a sum of $89,250 (£18,320) to the good, with visions of a large increase in my salary and a high-sounding title to go with it.

A few days later I was discussing the value of my discoveries in economy with our marine superintendent, and, wondering why he did not enthuse, when I received a call from a smooth-looking and smooth-talking individual, who presented a letter of introduction from a friend of mine, stating that the bearer was honest, trustworthy, upright, painstaking, earnest, gentle and kind, and that he had something to submit to me which he (the writer) believed worth while considering, etc.

New Lubricants Are Offered to Reduce Our Coal Bills Still Further

I had long suspected that the lubricants we were using were full of grit and sand and other substances calculated to impair and destroy the efficiency of our engines because our repair bills were unusually high and our ships' engineers attributed the poor speed obtained in part to the inferior quality of coal furnished, but chiefly to the inferiority of engine oils supplied.

Here was a man who manufactured, refined and sold lubricating oils—and the letter said he was honest. What better could I do for my company, whose interests I had at heart, than to put myself in his hands? I questioned him as to the viscosity and density and many other properties that oils are supposed to possess, but of which I knew nothing, merely to impress him with my apparent knowledge of such matters.

He replied very candidly that his company's products were the best, and because the best, the cheapest, adding that no matter what we were paying for oils he would sell his product 5 percent cheaper just to introduce us to a good thing and to make us his friends forever. "For," he added, "once you begin to use our article you will perceive a decided improvement in the speed of your ships, due to the lesser friction in their engines.

"This, he said, "will also be reflected at once in your coal bills, and at least 15 percent will be saved; so that if hitherto you have burned in a trip, say, a thousand tons of coal, you will hereafter make the same trip under the same conditions with a consumption of 850 tons."

Our Expected Fuel Savings Total Nearly 40 Percent

I asked him where and how he carried on the experiments that made him so cocksure of the value of his lubricants, and he admitted that none had taken place on *ships,* but such experiments had taken place on *land plants* on the Jersey meadows, so close, however, to salt water that for all practical purposes the tests could well be considered to have taken place at sea.

I gave him the order in perpetuity and made a note in my book of another 21,675 tons saved, and called the traffic manager in consultation.

"The saving in coal," I said to him, "gives us additional space for cargo."

The decrease in dollars for coal not consumed and the added increase in earnings from additional cargo carried and freight earned looked very good to me.

Surely, I said, the directors will pay me a substantial bonus when I prove to them that I have to date saved fully 38.287 percent in coal, to say nothing of giving the ships space for additional accommodations and increasing their freight-earning power.

The Fresh Water Problem Is Attacked

The enormous quantity of fresh water used by ships in the regular course of their travels, and the exorbitant price that at foreign ports had to be paid—or at least was charged in the accounts that our agents periodically sent with accompanying vouchers and with stamps of approval affixed thereto—led me to make an inquiry into the matter, and in some mysterious manner (which in my innocence I have failed as yet to discover) the mere idea of making such an inquiry had hardly taken form in my mind when I received a call from the agent of a concern that manufactured, installed and guaranteed the working of evaporators, that is, machines with which quantities of the common and ever-abundant salt water of the seven seas could be converted into fresh water free from the injurious effects that salt has upon ordinary boilers.

That from twenty to forty tons of briny liquid could in twenty-four hours be converted into the softer liquid had not entered my soft-brained head, and the evaporator man found in me ready ears and a very receptive mind when he proposed to install evaporators in all of our ships, thereby effecting not only the saving which would accrue by reason of the lesser quantities of water that we would have to purchase and carry, but, as my friend pointed out, would indirectly save the coal pile, because, as he ingeniously explained, the fuel required to generate the heat to evaporate the requisite quantity of water would amount, as he had proven by actual tests, to 10 percent of the fuel required to project a more heavily laden ship carrying the same quantity of water in her tanks, and this, he added, amounts in a forty-ton evaporator to approximately 15 percent of the total coal ordinarily consumed in a boat of average displacement and speed.

Forty-Ton Evaporators Are Ordered

I at once closed a contract for a large number of forty-ton evaporators, and jotted down in my book another item of saving, perfectly assured of the prospects of my being counted chief among all American steamship operators.

Many people question the power of mind-reading. I never believed in it until a day or two after the closing of the evaporator contract the sales manager of an en-

gineering company that made a feature of feed water heaters walked into my office and told me confidentially that he had called for the sole purpose of saving my company big money. (It reminded me of the fakir at Coney Island selling rings at five for a dime, the purchaser having the privilege of tossing the rings with the object of putting through them canes placed perpendicularly a short distance away, all the while proclaiming in a loud voice: "Gentlemen, remember that we are not here to make money; we are here solely to give away canes!")

Feed Water Heaters Are Next Introduced

The sales-manager unfolded a scheme that actually made me open my mouth in wonder. Here was an apparatus that heated water before it entered the boilers, thereby generating within them an even, normal, regular, constant, continuous, permanent, efficient, live steam. He used all these words to impress me! Instead of steam blowing hot and then blowing cold, as is the case under the ordinary method of pumping and filling, you have, of course, a constant supply of hot water pouring into the boilers as fast as the water therein evaporates, quickly replenishing the live steam as it finds its way to the engines.

"Careful calculations, checked and verified by numerous rigorous tests, show," he said, "that in passenger ships of high speed a saving in fuel of not less than 15 percent is effected where our feed water heaters are used."

"Therefore," he added, "I cannot too strongly recommend their adoption by a company that is so ably managed as yours."

I asked him if he had ever been to sea and personally tested the heaters under the varying conditions of a long voyage. By dint of patient and tactful cross-examination I finally got him to admit that he had never steamed beyond the fishing banks on the good old side-wheeler *Angler*.

And, as the man told me that all he sought was to save us money, I felt so grateful to him that I showed my appreciation by placing an order forthwith for the requisite number of feed water heaters, with the understanding that if they proved satisfactory we would cheerfully give him an elaborately worded testimonial of their worth.

Superheaters Are Installed

Have you ever heard of superheaters? Superheaters are cleverly devised drums placed on the tops of boilers to store steam and keep it dry before it enters the main steam pipes on the way to engine cylinders or turbines. Marine boilers frequently prime; that is to say, they bubble over, creating a foam that chokes the pipes and engines. Superheaters were designed to obviate this difficulty, but I was ignorant of this because our engineers had not enlightened me on the subject; therefore, when a kind-hearted agent appeared one day with a proposition to install superheaters on all the boilers of our ships I became interested.

Well, nothing would do but we must adopt the superheaters and be in the fashion. All the live steamship companies had installed superheaters. Had we? If not —why not? We must eventually. If eventually, why not now? To use fuel for the mere sake of seeing it turn water into bubbles, instead of good, dry, powerful, live steam was foolish. A saving of at least 15 percent in the quantity of coal would be effected by installing these very necessary appurtenances to our generating units. The agent said so, and the order went forth at once to have the installation made. Let it be! And it was!

Another cut in the economy stick! Another saving of at least fifty thousand tons in fuel! Another substantial volume of space allotted to cargo, with all the collateral benefits that would accrue from decreased displacement, enlarged capacity and improved speed.

Engineers tell us that the loss in power caused by unavoidable friction of engine parts equals not less than 80 percent, and that speed is reduced proportionately. The importance, therefore, of having certain portions of a complicated system of machinery parts that revolve around or within other parts protected by soft metals that will hold securely without undue binding is, apart from the saving in the wearing of parts, a very essential factor in a well-designed engine.

My interest was thoroughly aroused, therefore, when I learned of the anti-fake and anti-friction yellow metal composition, produced under a secret process, and a request for information brought a representative of the manufacturers, who, after many explanations, showed me that a saving in fuel of from 10 percent to 25 percent (according to the type, speed and character of the propelling machinery) could be obtained.

Making allowances for the extravagant claims that I imagined the agent was making, I conservatively figured that 15 percent in saving would not fail to result if we remetaled all the bearings of all the engines in all the ships in the service; and in due course the necessary orders were issued and the repair yard—ever eager to do a good turn—reaped a harvest in tearing out and fitting in the new bearings.

By gradual steps, or by what I might term a process of amortization in the application of economy, I had now arrived at a fair estimate of our accumulated savings in fuel of no less than 95 percent of the normal consumption. But it was not enough!

Fuel Savings of 95 Percent Not Enough!

When soon thereafter my attention was called to certain patented devices called retarders, conceived and placed in the market for the purpose of regulating and curtailing the excessive inductive air drafts to which ordinary ships' furnaces were subjected, I sent for the manager of the makers, and in a short time became convinced that the installation of such retarders would lead to a very considerable saving in the operating expense of our propelling units.

One of the main advantages that (since its adoption) oil fuel has shown to possess over coal fuel is that the heat produced by the former is constant, while with coal furnaces, which require frequent cleaning, replenishing, regulating, etc., the generation of steam is arrested and the even speed of vessels affected.

To avoid as much as possible the sudden drops in heat energy, firemen usually take turns at their respective stations and open furnaces assigned to each and feed them in rotation. Yet the loss in energy is very considerable, and the result is that no ship speeds along (sea currents and winds remaining constant) at an even rate. It follows, therefore, that the speeds recorded for vessels at sea are always average speeds.

The importance of providing a suitable check to this condition was apparent, and I promptly took measures to install the new apparatus, feeling assured that the saving of gases (which, unburnt, were drawn through the ship's stacks without profit) would more than compensate for the expense of installing the retarders.

This saving, I calculated (based on figures furnished by the makers) to be 15 percent of the fuel which under ordinary conditions would be consumed, and my book recorded another decrease in consumption, which in

terms of finance I conservatively put down at $15,000 (£3,080).

Numerous other devices to further reduce consumption of fuel were contracted for by me during the following months. The ships were apparently making good time and performing their respective services without hindrance. All the coal consumed by the entire fleet amounted—according to my records—to the quantity that would ordinarily be consumed in the Baltimore heater of an East Side boarding house parlor.

I had achieved the impossible!

I had sounded the death knell of the coal barons.

I had released for the use of other industries enormous quantities of fuel!

I was a public benefactor—the peer of steamship operators—a veritable wizard!

In the course of time the ships' accounts were prepared and submitted by the auditors, and I discovered—first with distrust and doubt, then with amazement and horror—that they contained charges for coal purchased at outports at prices ranging from 100 percent to 200 percent in excess of the contract prices at home.

The investigation that followed showed that our marine superintendent, having come to the conclusion that I was suffering from "dementia economica," had (to save our business from perdition) secretly ordered the replenishment of the ships' bunkers at foreign ports where coal was scarce and excessively dear——

AND THEN I AWOKE!

Marine Oil Engine Construction and Motorship Building in Europe

BY OUR SPECIAL LONDON CORRESPONDENT

WITH the improving supplies of raw material in Europe there are signs of increasing production of motor ships, and the largest vessels of this type so far built, the *Glenariffe* and *Stureholm,* have recently been completed at Glasgow and Gothenburg, respectively, while the *Buenos Aires* was launched at the last-named port a short time ago. It is hoped that within the next month two of the largest motorships ever constructed will be put into the water, one at Glasgow and the second at Copenhagen, both the vessels having a deadweight carrying capacity of 13,000 tons.

The *Glenariffe* is a 10,000-ton ship owned by the Glen Line and is a product of Messrs. Harland and Wolff, who are now occupied to the fullest possible extent in turning out large motor ships at Glasgow. The new vessel is 406 feet in length and is equipped with two four-cycle engines of the six-cylinder type, developing 1,800 indicated horsepower at 115 revolutions per minute and having cylinders 26⅝ inches diameter and 39⅜ inches stroke. The *Stureholm* is owned by the Swedish-American-Mexican Line and carries 9,200 tons at a speed of 11 knots, being fitted with two 1,300 indicated horsepower engines built under license from Burmeister and Wain in Sweden. The *Buenos Aires* is of approximately the same size, but is equipped with rather larger motors, each developing 1,550 indicated horsepower. She is owned by the North Star Line of Stockholm, which firm already has a very large fleet of motorships and has four more under construction of the same type.

Use of Steam Eliminated

An interesting feature of these new vessels, and, indeed, of most of the motorships which have recently been constructed, is that steam is practically entirely dispensed with and all the auxiliaries are electrically operated, in some cases even the heating of the ship being effected by means of electric radiators. It is true that electrically driven auxiliaries, such as winches, steering gear, etc., are rather more costly to build, but they are less expensive in upkeep and generally so much more convenient than steam plants that owners having had experience with both types are now invariably adopting the electrical system.

So urgent has the demand for new motorships become in Scandinavia that owners are finding it quite impossible to get new vessels built owing to the existing yards being fully occupied with orders in hand. Many Norwegian shipowners are therefore attempting to obtain such ships in Great Britain, but even there facilities are limited, and the number of engineering firms with sufficient experience in the manufacture of marine oil engines is limited. In order to cope with the demand and to avoid the long period of experimental work necessary if an oil engine is to be developed from the very beginning, licenses are being taken up by prominent British shipbuilders for the manufacture of well-known Continental engines. In this way it is hoped to increase the output of motorships rapidly in British yards, and before the end of next year it is anticipated that the motor shipbuilding industry will have developed to an enormous extent.

In the meantime, with this shortage of available oil engines and the difficulty of producing them quickly, the British Admiralty is disposing of a large number of submarine engines, which are no longer required. Many of these motors are of 800 horsepower of the well-known Vickers type, and the surplus supply of these sets may be realized when it is stated that at the time of the armistice there were no fewer than twenty leading engineering concerns in Great Britain building submarine Diesel engines of the Vickers type. All the engines under construction were completed, and as very few of them have been required for new submarines they are being disposed of privately whenever the occasion offers.

Adaptability of Submarine Type Diesels

It will be of interest to American shipowners, who, no doubt, have heard various reports regarding the reliability or otherwise of large auxiliaries, to learn that many of these submarine engines are being installed in existing sailing ships. Several such vessels belonging to the Anglo-Saxon Petroleum Company have been converted into motor tankers, and many of these conversions were actually carried out in China, Australia and other parts of the world in vessels trading in those districts.

Two 5,000-ton ships were recently equipped with a couple of 800-horsepower Vickers engine in Hong Kong, the motors being dispatched from Great Britain. Several others in Australia have been fitted with hot-bulb engines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of the 320-horsepower Bolinder type, originally intended for naval craft. This method of disposal of oil engines built for war purposes certainly has its advantages, especially at the present time, when long delays are occasioned in manufacture, owing to labor troubles and shortage of materials.

New Type of Oil Engines

A new type of oil engine is now being manufactured by several firms in Great Britain which may lead to important developments in marine oil engine construction. At present the well-known firms of Crossleys, Ruston and Campbells are building the new engine for stationary purposes, but the first-named concern will shortly manufacture it for marine work as well. It is a four-cycle machine and aims at obtaining the same results as the Diesel engine without the complication of the latter. Its only difference in principle from the ordinary stationary four-cycle oil engine is that the compression pressure is a good deal higher, being between 300 and 400 pounds per square inch, while the combustion chamber is of special design and is almost spherical in shape. Fuel is injected into the combustion chamber mechanically through an atomizer of less delicate construction than that of a Diesel engine.

With this motor the fuel consumption is not more than 10 percent higher than with the best Diesel engine (averaging about 0.42 pound per brake horsepower hour), but, owing to its simplicity and the lower pressure, the cost of construction is relatively small, being somewhere in the neighborhood of $60 per brake horsepower, as against $100 per brake horsepower for most Diesel marine engines at the present time. It is, of course, started by compressed air in the ordinary way, but no heating is required as with the semi-Diesel engine. It may seem strange that results can be achieved which it was formerly thought were only possible with Diesel motors, and it would appear that one of the main reasons for the advantages gained is that the combustion chamber is of the exact shape to allow very efficient combustion and atomization. At any rate, the engines are now being built, and long tests have proved that all the claims made are well founded.

Other Oil Engine Developments

Other interesting oil engines are now being developed and the activity which is being shown in this direction indicates that the marine oil motor has by no means reached its limit of perfection. One of these new engines will be a 1,000-horsepower semi-Diesel type, and as the highest powered set of this class that has ever been constructed previously is of 500 horsepower it is clear that the new engine will mark an important step forward in the design of hot-bulb motors. The first unit is now under construction, and if the trials prove it to be thoroughly satisfactory in every respect for marine work it will be standardized and built on a large scale in competition with Diesel engines.

Another interesting development is the new Diesel engine which is being brought out by the Tuxham Company, one of the best-known manufacturers of hot-bulb oil engines in Scandinavia. The new engine is of the two-cycle type and differs from every other Diesel motor in that the system of crank-chamber compression is employed. The object of this design is to eliminate the large scavenging pumps usually necessary and thus reduce the cost of construction. The disadvantage is that the fuel consumption is somewhat higher, while the enclosed crank chamber renders the examination of the connecting rod and connecting rod bearings a somewhat troublesome proceeding. The first motor of the type will shortly be put upon the market, and it will be built in sizes from 250 brake horsepower upwards.

Congress Seeks a Merchant Marine Policy

Senate Committee on Commerce About to Take up Legislative Measures Relating to the Government-Owned Merchant Fleet

BY WALDON FAWCETT

With the advent of 1920, the upper house of Congress, after numerous delays and digressions, seems at last disposed to grapple with the question of determining upon the public policy with respect to the expanding American merchant marine, nurtured of wartime conditions. This means, of course, that Congress as a whole is in a fair way to accomplish conclusive results in this quarter. The House of Representatives, it must be conceded, had shown, prior to the adjournment of the extra or special session in November, a readiness to proceed with a definite merchant marine programme having duly approved the Greene bill, which constitutes a long step toward the permanent disposition of the war-begotten fleet, but so long as the Senate refrained from sympathetic action the initiative in the House counted for little.

Now that the Senate committee on commerce has announced that it will in mid-January enter upon consideration of a whole group of proposed legislative measures it is reasonable to suppose that determination of a Federal policy is in sight, even though a certain amount of time be required for compromise in the event that the Senate prefers its own plan for the disposition of the Government-owned fleet to that to which the lower House has given formal approval. That shipping and shipbuilding interests are alert to the formulation of a plan of action that will conserve the resources that the war has inspired and encourage their expansion is shown by the large number of spokesmen for the industry who have indicated that they wish to be heard.

The Senate committee will open on January 12 its general hearings on the fundamental questions of merchant marine policy, but four days earlier there will be inaugurated what promises to be a spirited discussion of a plan whereby the United States Shipping Board would be authorized to adjust the claims of wooden-ship builders arising out of the prosecution of the war. This is, in effect, an effort to have the national government fulfill in reasonable degree the oral promises made to wooden-ship builders in the days when a prolonged war was in prospect and when Government officials, in eagerness for the speedy provision of maximum shipbuilding capacity, encouraged builders to provide plants and equipment, but did not, ere the signing of the armistice, confirm their verbal assurances with regularly executed contracts.

The remedy for a situation that is clearly calculated to work hardship and injustice upon many wooden-ship

builders was projected by Senator Jones of Washington, and the bill is designated officially as S. 3451. The bill authorizes the Shipping Board to adjust, liquidate and pay the claims of individuals, firms or corporations who built or contracted to build wooden ships for the United States after April 6, 1917, and which cannot be paid under the law as it now is. It is provided that no claim shall be liquidated or paid unless it is found to be based upon a request or demand of the Shipping Board, the Emergency Fleet Corporation or a representative of them. Claims must be filed with the Board within three months of the approval of the act. In order to be made a basis for claims, moneys must have been invested or obligations incurred (incident to the production of ships) prior to November 12, 1918, and it must appear that obligations were incurred in good faith upon assurances of a representative of the Government that reimbursement would be provided in money or contracts for additional work. No profits are to be considered in claims and no investment for speculative purposes. In settlement of claims under this act there would be taken into consideration the salvage or usable value of any machinery, etc., purchased to equip wooden-ship building plants.

Miscellaneous Shipping and Shipbuilding Proposals

With the problem of ways and means to afford satisfaction to the wooden-ship builders out of the way, the Senate committee on commerce will undertake to consider, with due relation to one another, all the miscellaneous shipping and shipbuilding proposals that are before it. As a basis for general legislation dealing with the merchant fleet the upper branch of the Legislature has, of course, the bill that has been approved by the House, and as alternatives there are various bills put forward by members of the Senate. Senator Jones, chairman of the committee, has his own version of the plan that should be followed in the sale, charter and operation of vessels.

The House committee on merchant marine, while waiting for the crystallization of sentiment in the Senate on, the basic question of merchant marine policy and the future programme of the Shipping Board, will take up a number of miscellaneous bills dealing with the merchant marine, such as the bill sponsored by the chairman of the committee which has as its purpose the granting of permission for the transportation of a limited number of passengers on cargo vessels. Hearings will also be inaugurated in contemplation of reporting to the Legislature with a recommendation for passage a bill providing for the classification of vessels owned by the United States via the instrumentality of the American Bureau of Shipping and for the recognition of the Bureau as the official agency of all the departments of the United States Government and all commissions created by the Government.

A Bill to Abolish "Commercial Bribery"

Ship outfitting and equipment interests will be required to exercise caution in the solicitation of business if Congress decides to give place on the statute books to a measure which has been put forward incident to a general movement at Washington to put an end to that form of salesmanship known as "commercial bribery." Contact with the shipping industry is to be established via a bill (H. R. 9572) introduced by Congressman Miller, and which would prohibit the payment of gratuities to the masters of vessels or other persons for the purpose of inducing or securing contracts for repairing vessels or furnishing vessels with supplies or other necessaries. "Any commission, bonus, gratuity, sum of money or other thing of value" may not be received or solicited directly or indirectly, under the terms of this bill for the purpose of inducing the making or placing of any contract, "express or implied."

Disposal of the Cape Cod Canal

While sentiment has grown in Congress in favor of divorcing entirely from railroad regulation or control the censorship of freight rates on inland waterways and coastwise shipping routes it is interesting to observe the simultaneous growth of a movement designed to place within the ownership and management of the national government privately controlled waterways that might be denominated "keys" in the field of waterborne commerce. The most notable example is found in the effort to authorize the acquisition and operation by the United States of the Cape Cod Canal. This is provided for in the bill known as S. 2083, the recent hearings upon which before the Senate committee disclosed interesting details as to the strategic importance of this waterway and the volume of commerce for which it affords a short cut.

(U. S. Navy Official Photograph)

United States Battleship *Tennessee* Nearing Completion at the New York Navy Yard, Brooklyn, N. Y. Length, 624 Feet; Extreme Beam, 97 Feet; Mean Draft, 30 Feet 6 Inches; Displacement, 32,000 Tons; Horsepower (Electric Drive), 28,000; Speed, 21 Knots; Armament, Twelve 14-Inch and Fourteen 5-Inch Guns

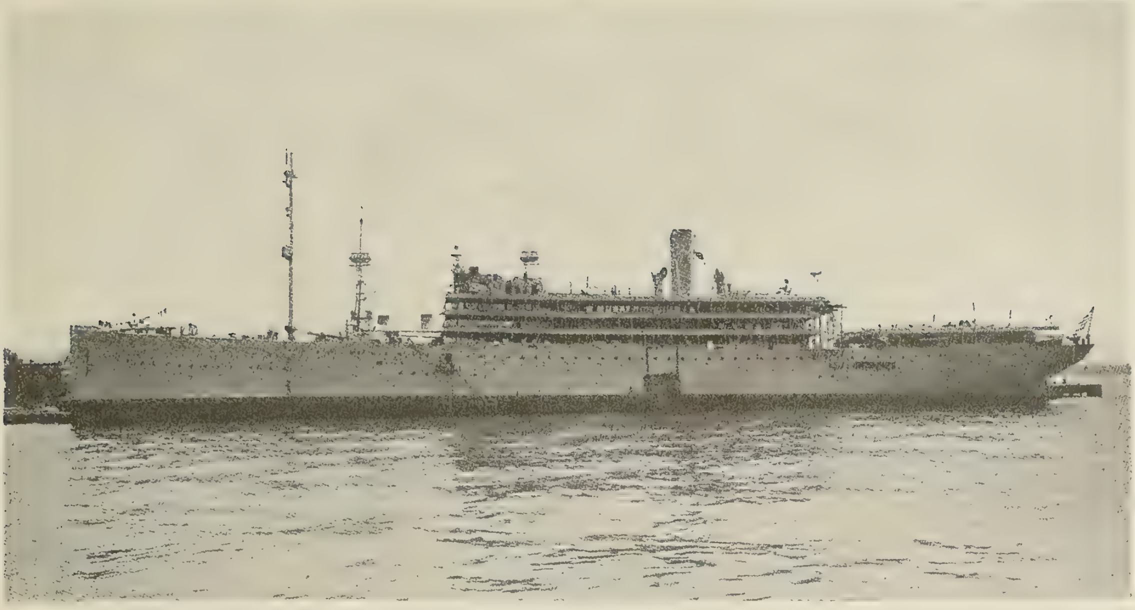


Fig. 1.—U. S. S. *Henderson* in Commission. Patch Is Over Twice the Size of Stabilizer

Non-Rolling Passenger Liners*

Observations on a Large Stabilized Ship in Service, Including the Plant and Economies Effected by Stabilization

BY ELMER A. SPERRY

NOW that it has been adequately demonstrated in the case of a number of important installations that a ship can be guaranteed against all rolling, a great forward step is possible and a new era opened up for the American passenger-carrying service. Plans are already in progress for an extensive adoption of the new principle, so that the benefits and economies resulting from a ship guaranteed against roll will be available to the traveling public.

In all previous attempts to prevent rolling the equipment has operated on the passive principle, depending on a certain amount of roll for the stabilizing moments, and the amount by which the roll has been reduced has never been satisfjactory, nor have the means themselves been practicable. Another difficulty is that the phase lag is found to be insurmountable, the stabilizing effect—such as it is—arriving "the day after the fair."

The active gyro stabilizer solves the problem and works entirely independently of the motion of the ship. Delivering full counter-moments to a motionless ship, it is free to deal directly with the wave slopes themselves, i. e., with the rolling increments of the sea as they are in the process of developing, even before incipient rolling has set in. The active stabilizer thus acts as a simple preventive of rolling, working in harmony with the slow period of the ship, yet dealing alertly with each increment as it arrives, irrespective of magnitude or direction; holding the ship most satisfactorily upon an even keel; demonstrating how little is really required to keep a ship from rolling, or, rather, from beginning to roll, if only a basically preventive method is employed.

With the complete solution thus in hand, accomplished with a small and simple equipment, it is believed that the older passive types, with their great weight, fractional results and uncertain operation, will become obsolete.

The difficulty with all of the older passive types can be reduced to an extremely simple proposition: With all of these methods of attack, a pound weighs only a pound and its effectiveness is measurable in simple terms of the lever-arm of its application, or the distance from the center of oscillation of the ship at which the moments become effective. This is the reason for the excessive and even prohibitive weights necessarily present in all these methods of reducing the roll of ships. On the other hand, in arriving at the powers available to stabilize the ship with the gyro, every pound is multiplied by the velocity of the particle, so that a comparatively few pounds are actually capable of doing the work of tons. With the active gyro this is all held in phase, and is available for the important purpose of holding the ship free from even the beginnings of roll.

Stresses in Hull from Stabilizer

Those unfamiliar with the subject, and even some naval architects, have feared that the forces and stresses involved might endanger the ship's structure in case of a heavy storm. The exact nature and magnitude of these stresses are perfectly well understood and have now been brought under careful observation in quite a large number of equipments in actual service. We are therefore speaking from a wide range of accurate knowledge on this important item, and it will be interesting to know that the conclusions by the highest authorities are that a ship which freely rides the waves with its mast held vertical, being completely stabilized by the little gyro equipment in her hold, is subjected to less than one-fourth and often less than one-sixth of the very large strains present when it is allowed to roll under exactly the same storm and weather conditions and with the heading unchanged in

* From a paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1919.

the same sea. With the gyroscopic stabilizer equipment on board, we have the unique situation of being able instantly to throw it on or off, in action or out, at will, by stopping its slow precessional movements, so that we can observe exactly what happens under the two conditions and repeat each condition as often as we choose and hold each under complete observation as long as we choose, under any given sea or weather condition. And just such tests as these have been repeatedly made and studies pursued until they are well known and understood. Thus the result of many observations and experiments, incidentally showing the great insight of Sir William.

Even some excellent authorities, before actually having the unique and extremely interesting experience of being aboard a stabilized ship, have confused a stabilized ship with a dock, expecting the waves to pound the ship when stabilized, and it is with great surprise and satisfaction that they have repeatedly discovered just the reverse to be true. A stabilized ship invariably rides the sea, gradually rising and falling with the sea with a wonderful degree of gentleness. Her masts quickly come to the vertical, and all pounding and splashing disappear as soon as stabilizing sets in.

Stabilized Ship a Dry Ship

This great authority went further and stated something that our highest authorities in this country then doubted, namely, that as soon as a ship was stabilized in a storm and rolling was prevented, that ship would not ship seas, but her decks would immediately begin to be dry and would remain dry. Although we did not at the time believe that this could possibly be true, our universal experience since we have had these installations in operation demonstrates the absolute truth of the statement, as the presence of the stabilizer on the ship reduces and holds to a very low value the stresses and strains which in the case of an unstabilized ship in storms often rise to high and dangerous magnitudes.

Everyone is familiar with the groanings, creakings and weird noises that are always present in heavily laboring or rolling ships. These illustrate the stresses and strains to which she is being subjected. Imagine the sensation when the stabilizer is thrown into action and these sounds cease forthwith, positively demonstrating that the heavy stresses have vanished. The stabilizer thus becomes one of the greatest safety devices yet invented, imparting absolute security to the great hull and structure of the ship and materially prolonging its life. All of this, of course, is wholly outside of the consideration of comfort, which is one of the prime reasons for the installation on passenger ships.

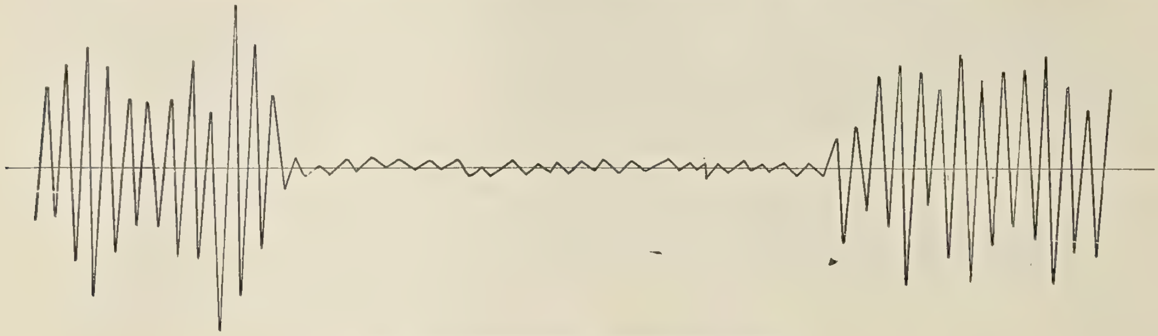


Fig. 2.—Characteristic Stabilization Curves

"Helm" Reduced in Heavy Weather

Other facts have been learned from the performance of the stabilizer in heavy weather. It is found actually to contribute a number of definite economies in the operation of the ship. Anyone who has ever undertaken to pilot a heavily rolling ship and to hold her to her course has realized the enormous amount of "helm" that is constantly required, and the resulting very sinuous course that the ship takes in spite of the best efforts the helmsman can make under these conditions.

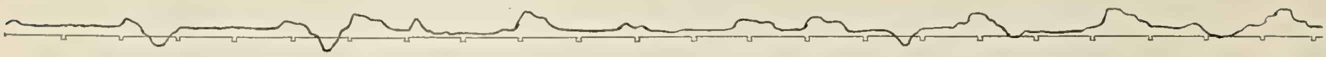


Fig. 3.—Automatic Record; Helm Required, Ship Not Rolling (Straight Line Indicates Rudder Center with One-Minute Intervals as Jogs)

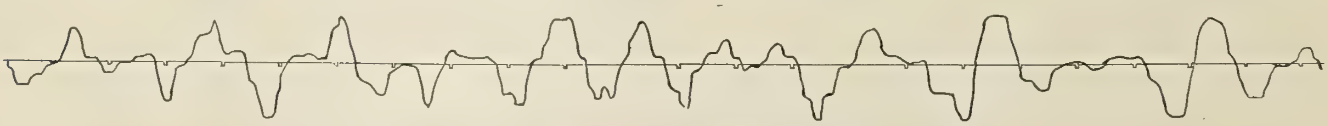


Fig. 4.—Automatic Record; Helm Required, Ship Rolling Heavily

In this connection it will be interesting from a technical standpoint to know that some time before the first stabilizer equipment was installed by the United States Navy the great English naval architect, Sir William White, was brought to this country in consultation on this subject. He stated, after careful review of the facts, that from the naval architect's standpoint the strains introduced by the gyroscopic stabilizer in holding a vessel absolutely free from roll were insignificant, and that if we laid hold of a single frame of an ordinary steel ship we would have a factor of safety of about six, and furthermore that these strains and stresses were only a small fraction of those existing in the hull and general structure of a ship when rolling in a storm.

No pains have been spared in studying this important phase of the contribution of the stabilizer. The gyro compass, with its enormous directive power, enables automatic records to be made of the most minute orientation of the ship. These have been secured and also simultaneous graphic records of the amount of helm being used by the ship, also automatic, so that there could be no question as to exactly what was happening. The study of

these records has been full of interest, developing an accurate method of analyzing and aiding to establish the losses under this division.

Fig. 2 shows a characteristic stabilization curve. Figs. 3 and 4 are helm records made on a 16,000-ton ship with the same series of helmsmen at the wheel. Fig. 4 clearly shows the threefold losses due to rolling: First, the sinuous course; second, the bad angle of attack and the wider path; and third, the direct retardation due to increased helm.

Operating engineers and naval architects know that even a very slight amount of "helm" acts as a tremendous retarder in the forward progress of the ship, and especially is this emphasized when a very large amount of helm has to be constantly employed. This slows down the ship, uselessly wasting a great deal of the propulsive power of her engines. Again, the sinuous course that is invariably steered by a wallowing ship causes it to travel a considerable extra distance, always accompanied with a "bad angle of attack," causing a large extra power consumption. A stabilized ship is practically self-steering. This comes as a sort of a bi-product of stabilization, the stabilized ship requiring practically no helm, regardless of weather.

But there is a still greater source of power waste in rolling ships. As the hull constantly oscillates back and forth, its form-lines encounter and constantly displace laterally, with extra friction of impact, hundreds, and even thousands, of tons of water, and this persists, going forward with every roll. This, in connection with the extra wetted surface involved, added to the extra streamline losses and skin friction impingement, especially when bilge keels are present, amounts to losses of very great magnitude in terms of actual horsepower wasted. Model experiments and resulting calculations indicate that these losses are much higher than have been supposed. For a 15,000-ton vessel at 18 knots—away inside the maximum roll—this loss may easily reach from 1,000 to 1,200 horsepower, and this power is absolutely dissipated and wasted.

Power Saved in Stabilized Ship

Just here the stabilizer steps in with a saving of nearly all of this—practically the entire amount, minus the small and comparatively insignificant quantity of power that is required to keep the gyro wheel spinning in a vacuum. In the course of a very few voyages this power saving in terms of fuel saving amounts to enough to pay for the entire stabilizing equipment.

Very full corroboration of this is found in the service performance of a fast passenger and cargo ship, by taking ten consecutive trips over the same course in the same direction with almost identical load conditions and under conditions of constant propeller revolutions. These trips are sufficiently long—4,600 miles—to be convincing in the results shown. These data have been plotted in revolutions per knot (see Fig. 5) and give an interesting and positive indication of the retardation of the ship owing to weather conditions. A very great amount of the losses in headway due to the retardation effect of the disturbances discussed above will be entirely eliminated by full stabilization. Let us examine what this means in dollars. Suppose the operating expense per 24 hours to be $6,000. The extra expense—that is, the expense over and above the average—in the stormy months amounts to not far from $100,000. This, taken with the amount saved through elimination of bilge keel losses, develops an earning capacity of the stabilizer of not far from 100 percent per annum. All of this is over and above the many other important gains, both direct and indirect, resulting from the stabilizer installation.

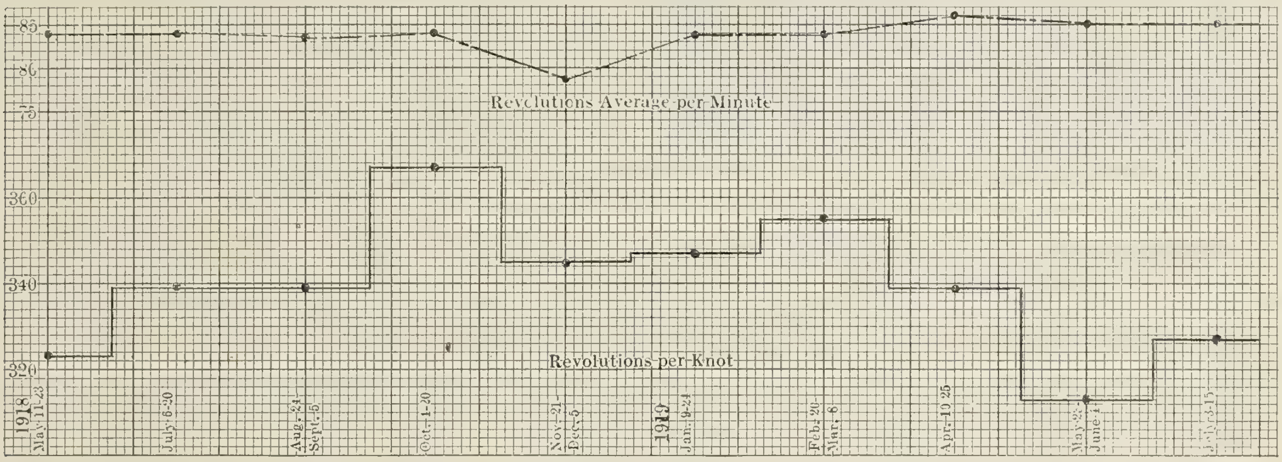


Fig. 5.—Data from Engineer's Log of Cargo and Passenger Vessel Showing Retardation by Weather Conditions in Winter Months

The stabilizer achieves another economy of very great significance to both the operator and the passengers of fast ships. This is the practical avoidance of the necessity for slowing down ships in stormy weather or when heavy seas prevail, the ships being able to make practically the same time under storm conditions. This has been repeatedly demonstrated and is a result so startling that, when first experienced, it has often been claimed as an original discovery by the skippers of stabilized ships.

So insignificant are the stresses required to prevent all rolling that it is interesting to compare them with or to state them in terms of the specific loading permitted by the underwriters. Take a concrete case of the transport *Henderson,* of 10,000 tons displacement, 488 feet length, with maximum beam of 48 feet and draft of 19 feet 9 inches—the allowable load per running foot for the section where the stabilizer is located is 14.5 tons. The load due to the weight of the stabilizer plus the maximum gyroscopic stabilizing moments, figured as load upon the vessel, is at maximum only 10 tons, and with average stabilizing moments about 6 tons per running foot. In other words, the stabilizer loads are much less than normal cargo loads. Some of the vessels carrying heavy machinery to France were loaded as high as 28 tons per running foot. The foregoing makes clear in a very practical way the relation these forces bear to the vessel's ordinary loads.

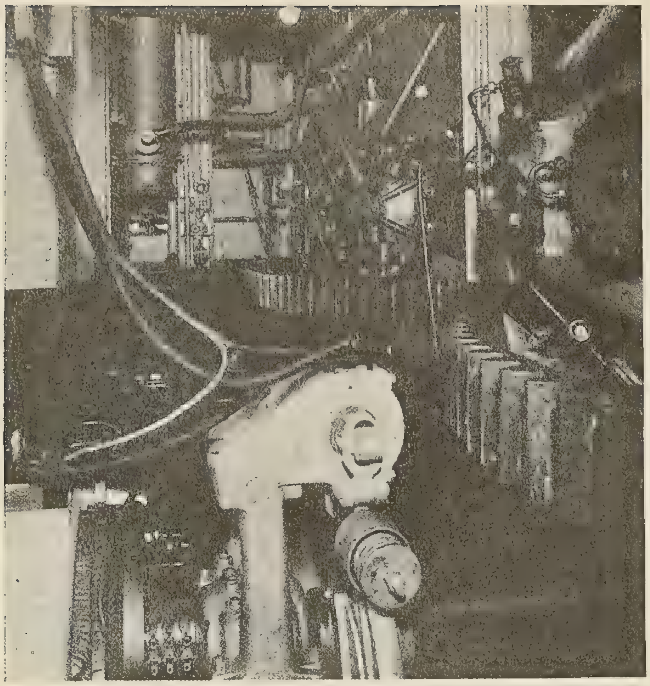


Fig. 6.—Stabilizer Room on U. S. S. *Henderson.* Main Gyros on Right, Precession Motor in Foreground

Another definite advantage secured by the stabilizer is the elimination of the bilge keels. Dealing only as they do with velocity squared, they can never be of service other than in the heaviest rolling—at all other times they are a positive menace. The well-known drag of bilge keels in perfectly calm weather is not only ever present, but represents positive losses, even in excess of those calculated. This has now been positively observed in the case of a large 20-knot ship, the performance with and without bilge keels for the same shaft revolutions, loading and trim being known. Moreover, a ship is never trimmed very accurately longitudinally, giving the bilge keels a frontal attack component with the attendant eddies, consuming additional power of no small magnitude.

Bilge Keels Eliminated

In rough weather the bilge keels afford an extra opportunity for the waves to lay hold of the vessel in rolling. Recently it has been definitely determined that the power required by bilge keels under the condition of pitching, even in a moderate sea, increases the propelling power to a point much beyond what has been supposed. In the case of a 10,000-ton vessel with standard keels, even with moderate pitching, an increase propelling power of about 9 percent has been observed. In a stabilized ship it is possible to eliminate bilge keels. There should be no hesitancy in omitting keels, as an exceptionally large and successful fast passenger ship has been operated without bilge keels for years.

A reduction in stresses of the propelling machinery of a stabilized ship represents another important gain, especially in the case of twin-screw vessels where the windward propeller is held very much more satisfactorily to its duty—not only saving power, but preventing the racking strains due to overspeeding when the screws are "rolled out." The efficiency of a propeller falls off abruptly as its blades even approach the surface, especially where the dip of the waves allows the slightest aëration of the water. For efficiency a propeller requires to be kept down in stiff water.

Prevention of deterioration in cargo applies especially to ships carrying live stock. Figures have been furnished by a concern transporting horses during the war, showing that, in a heavy storm during a single trip, their losses per trip often amounted to $30,000 or $40,000, a sum sufficient in a short period to equip the vessel with a stabilizer.

The ability to roll the ship has proved in actual experience to be important in case of emergency to free the vessel from sand and mud banks, by opening the contacting crevices and gradually liquefying the incumbent mass. This has been discussed in a former paper, also the field of the active gyro in rolling ice-breakers and preventing them from freezing in when cutting through rivers and harbors during the winter months. The most important use for rolling, however, is as an aid to gunnery.

Sea Experiences with Stabilized Vessels

As outlined, we have been accumulating a large amount of actual sea experience with various sized equipments. The war has seriously interfered with the work, but even during this period the Navy has allowed us to complete the largest gyro equipment yet attempted; and though the installation has been retarded by the ship being in constant transport service, this fact has offered additional opportunity for final testing. Fig. 1 gives a very good view of the U. S. S. *Henderson,* a transport built at the Philadelphia Navy Yard. Fig. 6 shows a corner of the gyro room on the *Henderson* with the precession motor in the foreground, and Fig. 7 shows the little control room with the rotary for generating A. C. current for spinning the gyros in the background. Directly in front of the rotary converter is the vertical gudgeon bearing which transmits the stabilizing moments through the ordinary steel decking to the ship's structure. This ordinary steel decking is found to carry the stabilizing moments with a large factor of safety. In the foreground is the special control gyro for the ordnance tests. In this case the gyro may operate in a single period successively as a stabilizer or as rolling equipment. Fig. 8 shows a curve of the *Henderson* automatically rolled by her special equipment when at sea under full headway.

This ship has operated with as high as 11,500 tons displacement, and the stabilizer has been repeatedly operated under overload conditions without difficulty, the journals running with perfect temperature control under the heaviest duty, including overload conditions. Even dif-

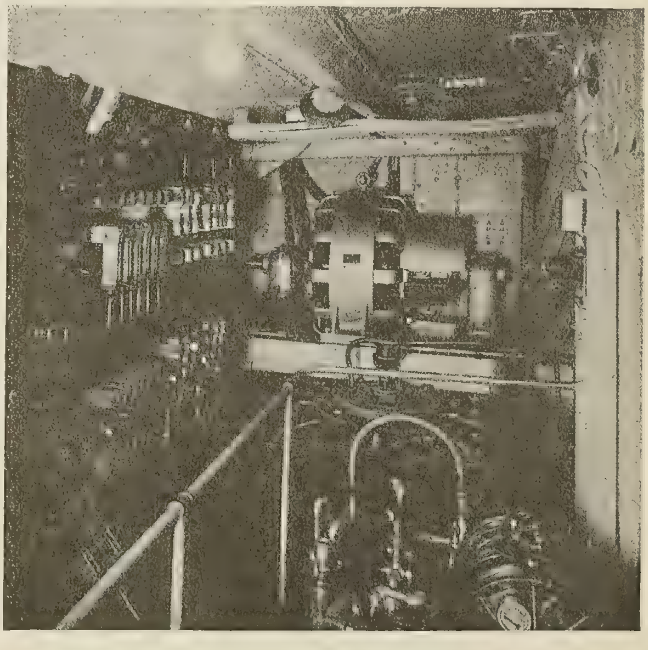


Fig. 7.—Control Room, U. S. S. *Henderson* Stabilizer

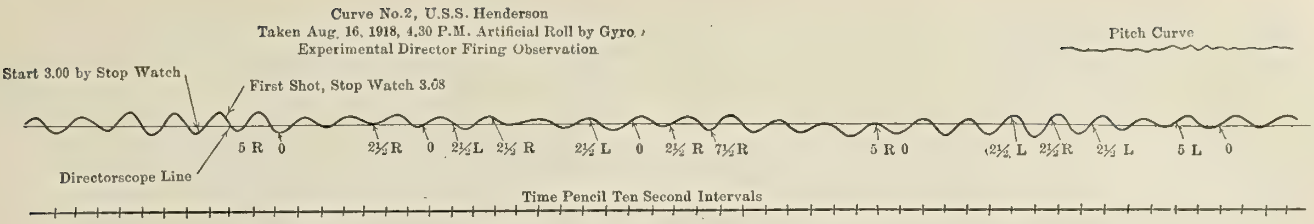


Fig. 8.—Automatic Constant Roll Imparted to U. S. S. *Henderson* at Sea

ferent lubricants have been tried, all giving about the same results; in fact, the plant, since the journals have been worked in, has operated normally in service, and the records show that the guaranteed stabilizing moments have been easily developed.

Fig. 9 shows a plain gyro oil bearing that has operated perfectly. This bearing has received over 100,000 precessions, many under overload conditions. This bearing was removed for photographing. The original tool marks and scraping are plainly visible. The oil groove to the left, with its far end partially stopped, and the corresponding diametrical one are the feeding grooves proper; the others are for flushing the revolving shaft surface with cooling oil and, together with the exterior holes, serve to hold the bearing under perfect temperature control as described.

Fig. 9.—Main Gyro Bearing Photographed After 10,000 Precession Loads, Tool Marks Still Visible

This equipment has undergone additional protracted tests as an ordnance fitting, reaching results in this connection which are extremely interesting; operating in this part of the work in conjunction with the base equipment of our latest fire-control system. The exacting nature of these tests and their severity have contributed in no small measure to another extremely interesting result as follows: The complete knowledge we now have of the behavior of these equipments and the measured results and records have placed us in a position to guarantee unqualifiedly the stabilization of practically any ship to accurate specification and also the equipment by means of which this important result is secured.

Plastic-Arc Welding Applied to Ship Construction and Repair

BY J. O. SMITH*

PLASTIC-ARC welding was being developed and used on some of the larger eastern railroads for a long time previous to the outbreak of the war in 1917. As a result of its successful application in welding heavy cast-iron locomotive and other parts, the Navy Department engineers turned to the plastic arc as a means of repairing the damaged German ships. The successful repair of the large cast-iron cylinders and other parts of the German ships has led naturally to consideration of arc welding in the manufacture and repair of metal products and parts of all kinds. The attention of engineers generally has been attracted by its possibilities, and the great achievement of successfully repairing the damaged ships has naturally given the subject great prestige among shipping and shipbuilding interests.

Use of the Arc in Shipbuilding

When the matter of welding in connection with ship construction is considered, immense possibilities immediately suggest themselves. It has been definitely determined by exhaustive technical study and experiment that welding can be satisfactorily employed in ship construction, that ship plates joined by welding will be as strong or stronger than the original metal at the welded joint, and that welding can be employed for ship construction work at a saving of 25 percent in time and 10 percent in material, as compared with riveting.

In actual figures, as determined by experiments of the Emergency Fleet Corporation's electric welding committee, the saving in rivets and overlapped plates would amount to 500 tons in weight on a 9,500-ton ship, where welding had been used.

Further investigations by this committee led to the conclusion that electric welded ships could be built at least as strong as riveted ships; that plans for ships designed to be riveted might easily be modified, to adapt them for extensive electric welding, and thus save in the cost and time of hull construction; that ships especially designed for electric welding could be built at a saving of 25 percent over present methods and in less time.

An electrically welded ship is credited with many advantages over a riveted ship. In a 5,000-ton ship about 450,000 rivets are used. A 9,500-deadweight-ton ship requires 600,000 or 700,0000 rivets. By the welding process the saving in labor on the minor parts of a ship is reckoned at from 60 to 70 percent on the hull plating and other vital parts, the saving in labor, cost and time of construction by welding is conservatively placed at 25 percent.

Lloyd's Investigations

Considerable investigation of the subject of welding instead of riveting has been made in England by Lloyd's Register of Shipping particularly with regard to formulating rules for the application of electrical welding to ships. As a result of the investigations and experiments made by the society's technical staff, it was determined that the matter has assumed such importance as to warrant the formulation of provisional rules for electrically welded vessels. These have been issued for the guidance of shipbuilders by Lloyd's Register.

The experiments conducted in England followed three well-defined lines of investigation; the determination of the ultimate strength of welded joints, together with their ductile properties; the capability of welded joints to withstand alternating tensile and compressive stresses, such as are regularly experienced by ships; and microscopic and metallurgical analyses to determine if a sound fusion were effected between the original and added metal.

* Engineer, Wilson Welder & Metals Company, New York.

It was determined that the tensile strength of the welded joints was from 90 to 95 percent of the original plates, as against a strength of from 65 to 70 percent in riveted joints, showing a margin of 25 percent increased strength in favor of the welded joints.

The result of the tests to determine the elastic properties of welded joints indicated that there was a slight difference in favor of the riveted joint. The art of welding has made such great strides recently, however, that it is believed entirely possible to make a welded joint in ship plates that will stand as great a number of reversals of stress as a riveted joint.

The microscopic and metallurgical analyses determined definitely that a good, solid, mechanically sound weld was made between the original and the added metal, the two metals having been fused together so perfectly that no line of demarcation could be seen.

The rules so far promulgated by Lloyd's have been necessarily of a tentative nature and will no doubt be modified and enlarged from time to time in view of the experience that will be gained after a few welded ships have been in service for a time.

In addition to the increased cost of riveting as compared with welding, it is nearly always true that there are a certain number of imperfectly fitted rivets, that do nothing more than add weight to the ship. The main purpose of a rivet, of course, is to bind two or more thicknesses of plate together, but if the rivet is bent or loses part of its head in the riveting process, or otherwise fails to function properly, there is no method by which such faults can be corrected after the rivet cools. Such defective rivets must be removed entirely if the importance of the riveted part requires a perfect joint. When it is considered that a 5,500-ton ship requires approximately 450,000 rivets to bind the various parts and plates, and also that a certain percentage of these rivets are not fulfilling the purpose for which they were intended, it is quite evident that practically every ship is burdened with a good-sized load of dead, useless weight. Such defective rivets are, in fact, more than a useless weight, in that they are a menace to the ship, for, while they have been built into the ship for a purpose and are supposed to be fulfilling that purpose, there is no telling how much the ship has been weakened structurally by their failure.

Reasons for Defective Rivets

There are many reasons for defective rivets, and one of the greatest of them is inaccessibility, and the consequent difficulty on the part of the riveter to put them in place properly. Then, too, there is no certainty that rivets are at a proper workable temperature. If they are too cold, the pneumatic hammer now generally used in riveting is unable to round off the end of the rivet properly and the plates are not bound together as they should be.

In many cases, when leaky rivets are discovered, the present-day method is to weld the defective spots, which immediately brings up the natural question why it would not be advisable to weld the plates at first.

The ability of a welder, using a direct-current, low voltage arc with automatically regulated current, to make sound mechanical welds in cramped, confined spaces on overhead or vertical walls—in fact, anywhere a man and a wire can go—naturally suggests that welding ship plates together should be the primary operation in shipbuilding.

A New Development in Hoisting Machinery

Horizontal and Vertical Movements of Loads Controlled by Single Drum—Dead Load Balanced by Counterweight, Thus Reducing Power Required for Operation

BY WARREN TRAVELL*

So much attention has been given during recent years to the design of hoisting machinery and the various types have been so highly perfected that an improvement in such apparatus embodying a new principle of operation is unusual.

Such an improvement in hoisting equipment has recently been developed by the writer and is applicable to all installations where vertical hoisting and horizontal traversing of loads are required. A single drum is used for these two movements in place of the customary two drums. The shift between vertical and horizontal motion is accomplished by means of a lever which controls a pair of rope grips.

Another important feature of this apparatus is that during the hoisting operation the entire dead load of the skip or bucket and half the live load is balanced by a counterweight, which reduces the size of the hoist and motor and also effects a large saving in the amount of power required as compared with other types of apparatus in which no counterweight is used.

During the operation of lowering, the motor is working to raise the counterweight, thus obtaining a control somewhat similar in effect to the well-known dynamic braking and much safer in operation than the common method of lowering with a brake. As the hoist drum is rigidly keyed to its shaft, no friction clutch is required and freedom is obtained from the troubles incident to this device.

This new type of balanced hoist and transporter is adaptable for use on hoisting towers, cargo cranes, traveling bridges, cable-ways and, in general, on all hoisting apparatus in which there is a free hoist and horizontal movement of the load. For grab-bucket work, there is required for the holding line an additional drum which may be of the counterweighted type, without connection to the motor. The advantages of this improved hoist may be briefly expressed by the statement that it uses one drum less and about half the power of the more common types of apparatus doing similar work.

In connection with this balanced hoist, another interesting improvement consists of an extensible boom, which is especially suited for use on cranes loading and unloading vessels. The boom may be extended or withdrawn in the direction of its own length and gives minimum interference with the stays, lines and wireless aerials of a vessel. An important feature in the design is the means adopted for paying out at a predetermined, varying rate of the ropes supporting the outer end of the boom. When used in combination with the balanced hoist equipment, the hoisting apparatus is operative at all points of extension of the booms. The slack rope resulting from the drawing-in of the boom is taken up by the counterweight. This enables the crane to handle freight on the pier while vessels are being moved alongside.

* Consulting Engineer, 25 Church street, New York.

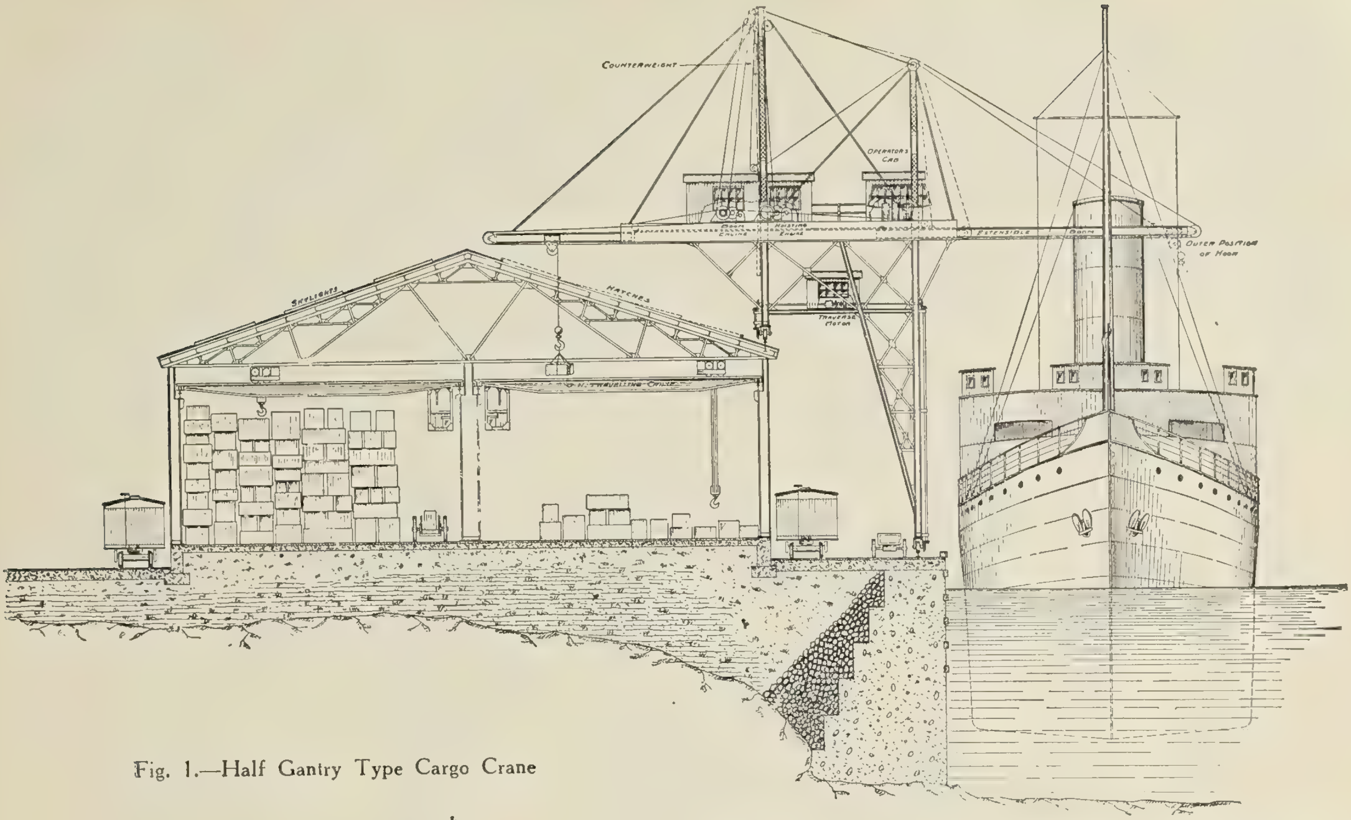


Fig. 1.—Half Gantry Type Cargo Crane

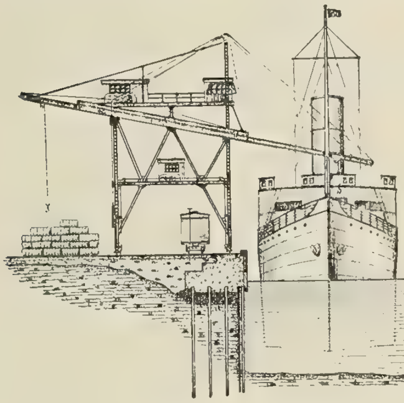


Fig. 2.—Full Gantry Cargo Crane

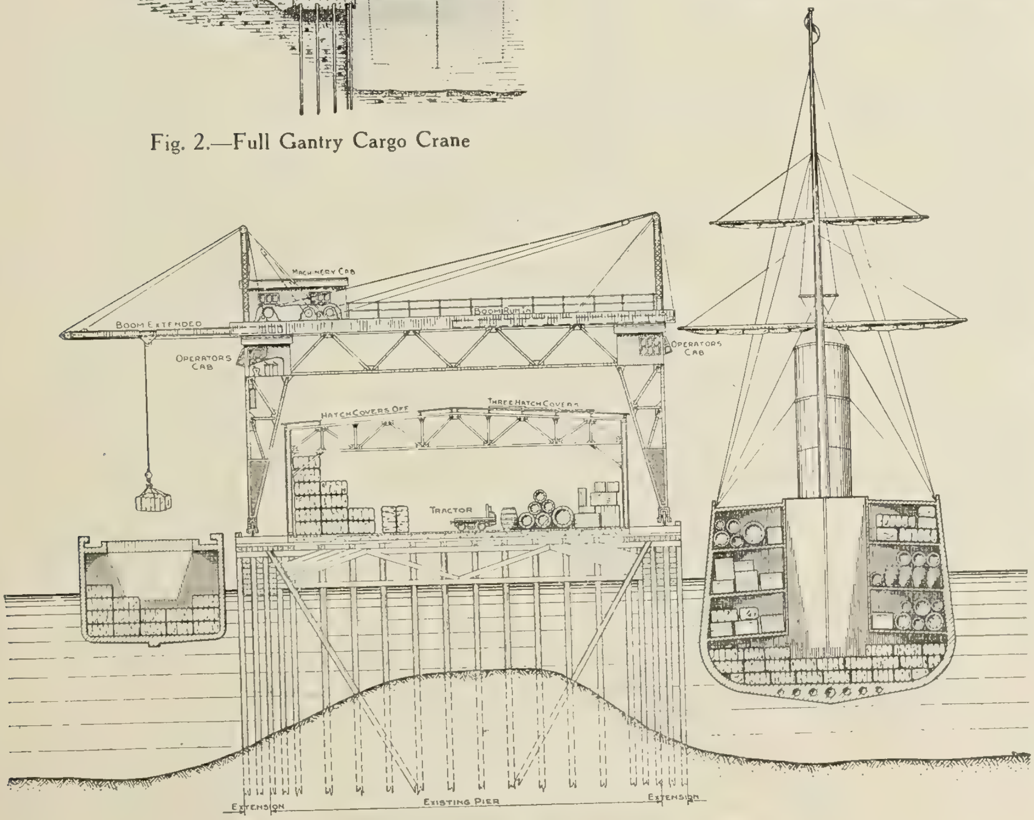


Fig. 3.—Special Type of Crane Spanning the Pier

The accompanying illustrations show three types of cargo cranes equipped with these improvements. Fig. 1 is of the half-gantry design with its short leg running on the roof of the freight shed. The space alongside, or "apron," may be of any reasonable width, permitting the installation of a driveway and one or more railroad tracks. Such a crane by operating through hatches in the freight-house roof can handle freight directly between the vessel and the shed, railroad cars and trucks. For ordinary service the crane has a capacity for handling loads of three tons at a speed of about 400 feet per minute and a traversing speed along the pier of 150 feet per minute.

To reduce manual handling to a minimum, the shed should be equipped with overhead traveling cranes or equivalent apparatus which will cover the entire floor area and make it possible to pile freight to a considerable height. Such auxiliary cranes may be used for the loading and unloading of trucks, the sorting and distributing of incoming freight, and stacking of outgoing freight in readiness for the next vessel.

Fig. 2 shows the full gantry with an inclined extensible boom. This design permits of a reduction in weight of structure from that required for a hori-

zontal boom and economizes power consumption by equalizing the work of the motor during hoisting and traversing.

In order to reduce to a minimum the length of time during which a vessel is at dock, a sufficient number of cargo cranes should be installed so that there will be a crane available for operating at each hatch of a vessel.

The type of crane shown in Fig. 3 is adapted for use on existing piers where the freight shed occupies practically the whole width of pier and the structures have not been built strong enough to carry the additional loads which would be imposed on them by cranes traveling on the roof of the building.

The only changes required for the installation of this crane are the construction of an additional narrow strip of pier along each side of the building and the cutting of hatches in the roof of the pier shed. The hatch covers, which are of raintight design, are handled by the crane hook.

This crane has a counterbalanced hoist and two extensible booms, which give a means for handling freight directly between barges or lighters on one side of the pier and a vessel on the opposite side, as well as to and from the freight house.

The more general installation in our ports of up-to-date cargo cranes and auxiliary equipment by reducing the cost of handling, saving the time of vessels and increasing the handling capacity of the piers, will help materially in reducing the present high cost of commodities.

Steel Cargo Steamer of 1,260 Tons Dead=weight

THERE has recently been completed by the Canadian Car & Foundry Company, Ltd., which has offices at 25 West Thirty-third street, New York city, a 1,260-ton steel cargo steamer named the *E. D. Kingsley*. The designs for this vessel were made by Cox & Stevens, naval architects, New York. She has a speed loaded of about 10 knots, and is owned by the Kingsley Navigation Company.

Classification is by Lloyd's Register of Shipping, the dimensions being as follows:

Length overall	210 feet
Length between perpendiculars	200 feet
Beam	32 feet
Depth at side	17 feet
Draft extreme	15 feet 9 inches
Displacement	2,096 long tons

The propelling machinery consists of a triple-expansion engine of 880 indicated horsepower, with cylinders 16 inches, 25 inches and 43 inches diameter, with a common stroke of 30 inches. Two three-furnace Scotch boilers, 11 feet 11 inches diameter by 11 feet 3 inches long, furnish steam at a working pressure of 190 pounds per square inch.

The engine room equipment includes a condenser with a cooling surface of 1,200 square feet, a Reilly feed water heater and a Reilly evaporator.

The auxiliary machinery comprises the following:

Vertical simplex air pump, 7½ inches by 14½ inches by 8 inches, of the Worthington type.

Centrifugal circulating 8-inch pump, Morris Machine Works.

Vertical simplex main and auxiliary feed pumps, 8 inches by 5 inches by 12 inches, of the Davidson type.

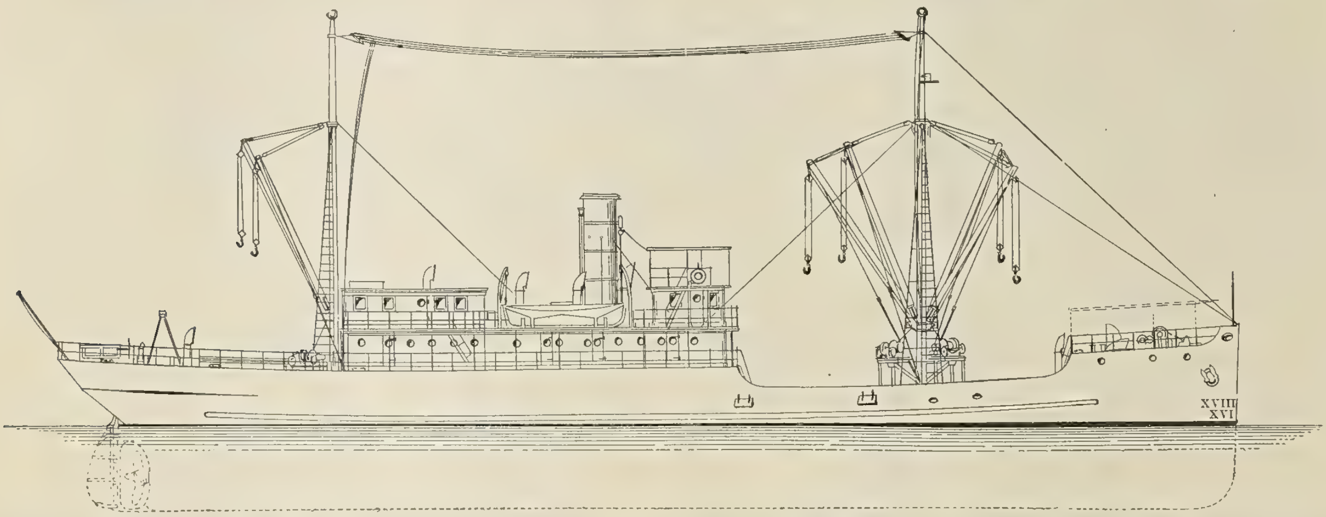
Horizontal duplex fire, bilge and general service pump, 7½ inches by 7 inches by 10 inches, of the Worthington type.

Horizontal duplex oil transfer pump, 7½ inches by 7 inches by 10 inches, of the Worthington type.

Horizontal duplex sanitary pump, 5¼ inches by 4¾ inches by 5 inches, of the Worthington type.

Horizontal duplex evaporator feed pump, 3 inches by 2 inches by 3 inches, of the Worthington type.

It is believed by the designers that this particular vessel, of which an outboard profile is shown in the illustration, is of the type that will attract considerable attention, inasmuch as there is a great demand for steamers of relatively small size for coastwise trade, particularly among the islands and in South America.



S. S. *E. D. Kingsley*, of 1,260 Tons Deadweight, Designed by Cox & Stevens for the Kingsley Navigation Company and Built by the Canadian Car & Foundry Company, Ltd.

Annual Meeting Institution of Naval Architects

The annual meeting of the Institution of Naval Architects will be held in London beginning on Wednesday, March 24.

MEETING OF ATLANTIC COAST SHIPBUILDERS ASSOCIATION.—The New York section of the Atlantic Coast Shipbuilders Association will meet at 6 P. M., January 14, at the Hotel McAlpin, New York.

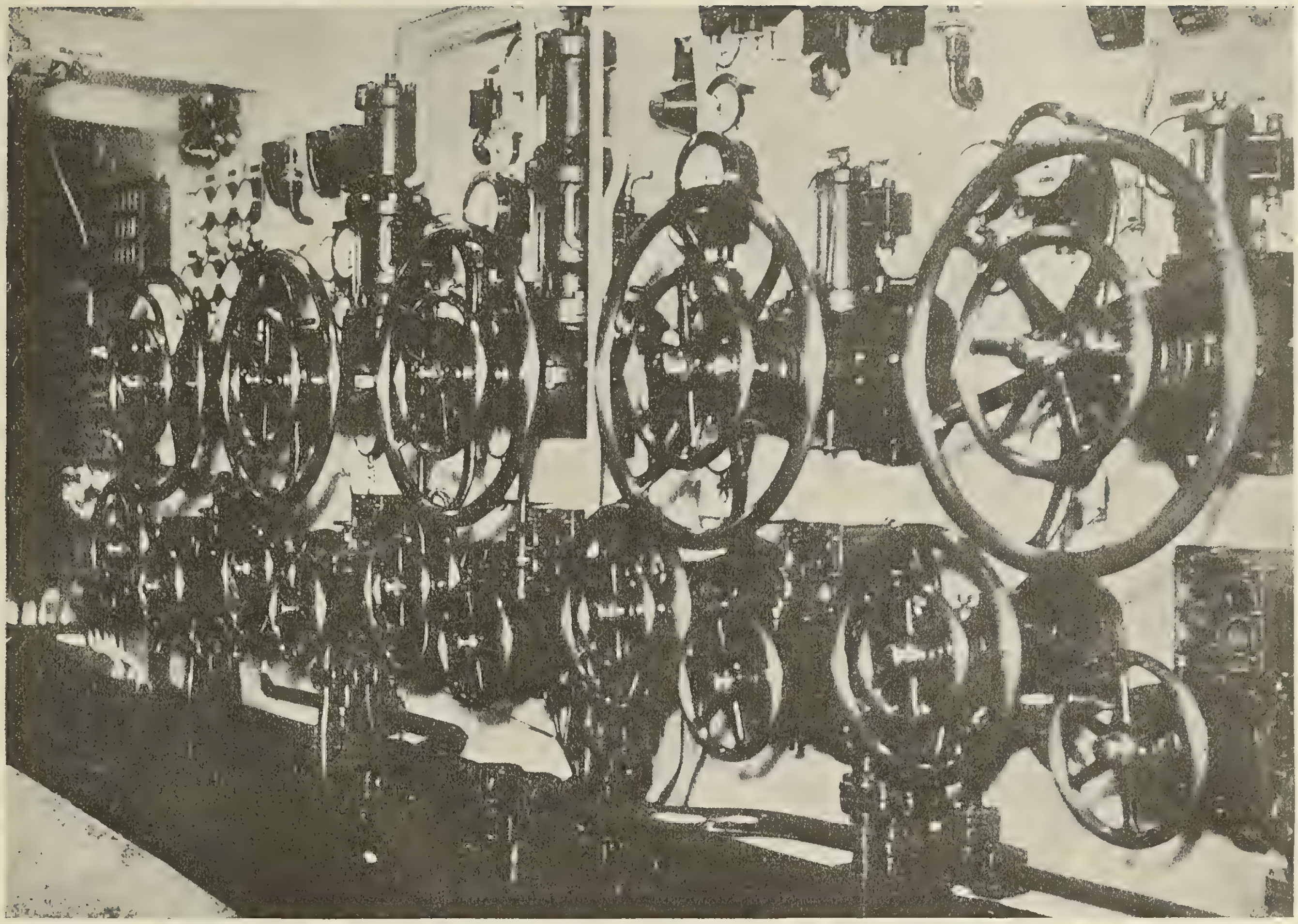


Fig. 1.—Arrangement of Hand Wheels of Maneuvering Gear on Working Platform in Forward Engine Room

Propelling Machinery of the Leviathan*

BY ERNEST H. B. ANDERSON

AT the outbreak of the war in 1914 the *Leviathan,* which was originally the *Vaterland,* the second of three large Atlantic liners which the Hamburg-American Steamship Company ordered to be built in Germany during 1911, had made one round trip between Hamburg and New York and had completed the outward run of her second voyage. The third vessel was not launched at the outbreak of the war, and it is highly improbable that she will be ready for service for some considerable time.

The *Leviathan* is the largest vessel ever completed.

* From a paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1919.

TABLE I.—DIMENSIONS OF LEVIATHAN AND OTHER LARGE VESSELS

	Leviathan	Imperator	Aquitania	Mauretania
Builders	Blohm & Voss, Hamburg	Vulcan Co., Hamburg	John Brown & Co., Clydebank, Scotland	Swan, Hunter & Wigham Richardson, Wallsend on Tyne, England
Owners	U. S. Government	British Ministry of Shipping	Cunard	Cunard
Date of completion	1914	1913	1914	1907
Length overall	950 ft.	905 ft.	901.50 ft.	765 ft.
Length between perpendiculars	......	880 ft.	865 ft.	760 ft.
Breadth	100 ft.	98 ft.	97 ft.	88 ft.
Depth, molded	63 ft.	62 ft.	64 ft.	60.33 ft.
Gross tonnage	54,190	52,117	46,500	32,000
Draft	38.50 ft.	35.50 ft.	36 ft.	33.50 ft.
Displacement	63,100 tons	57,000 tons	53,000 tons	38,000 tons
Type of engine	Parsons turbines	Curtis Parsons turbines	Parsons turbines	Parsons turbines
Number of shafts	4	4	4	4
Type of boilers	Watertube	Watertube	Scotch double-ended	Scotch double-ended
Number of boilers	46	46	21	21 D. E. 2 S. E.
Number of furnaces	138	138	168	192
Steam pressure	235 lbs. per sq. inch	235 lbs. per sq. inch	195 lbs. per sq. inch	195 lbs. per sq. inch
Total heating surface	210,440 sq. ft.	203,009 sq. ft.	138,595 sq. ft.	158,350 sq. ft.
Total grate surface	3,843 sq. ft.	3,763 sq. ft.	3,541 sq. ft.	4,048 sq. ft.
System of forced draft	Howden's	Howdens	Howden's	Howden's
Total S. H. P. of ahead turbines	65,000	61,000	60,000	68,000
Speed in service	22.50 knots	22.50 knots	23.50 knots	25 knots
Revolutions per minute	170	170	165	180

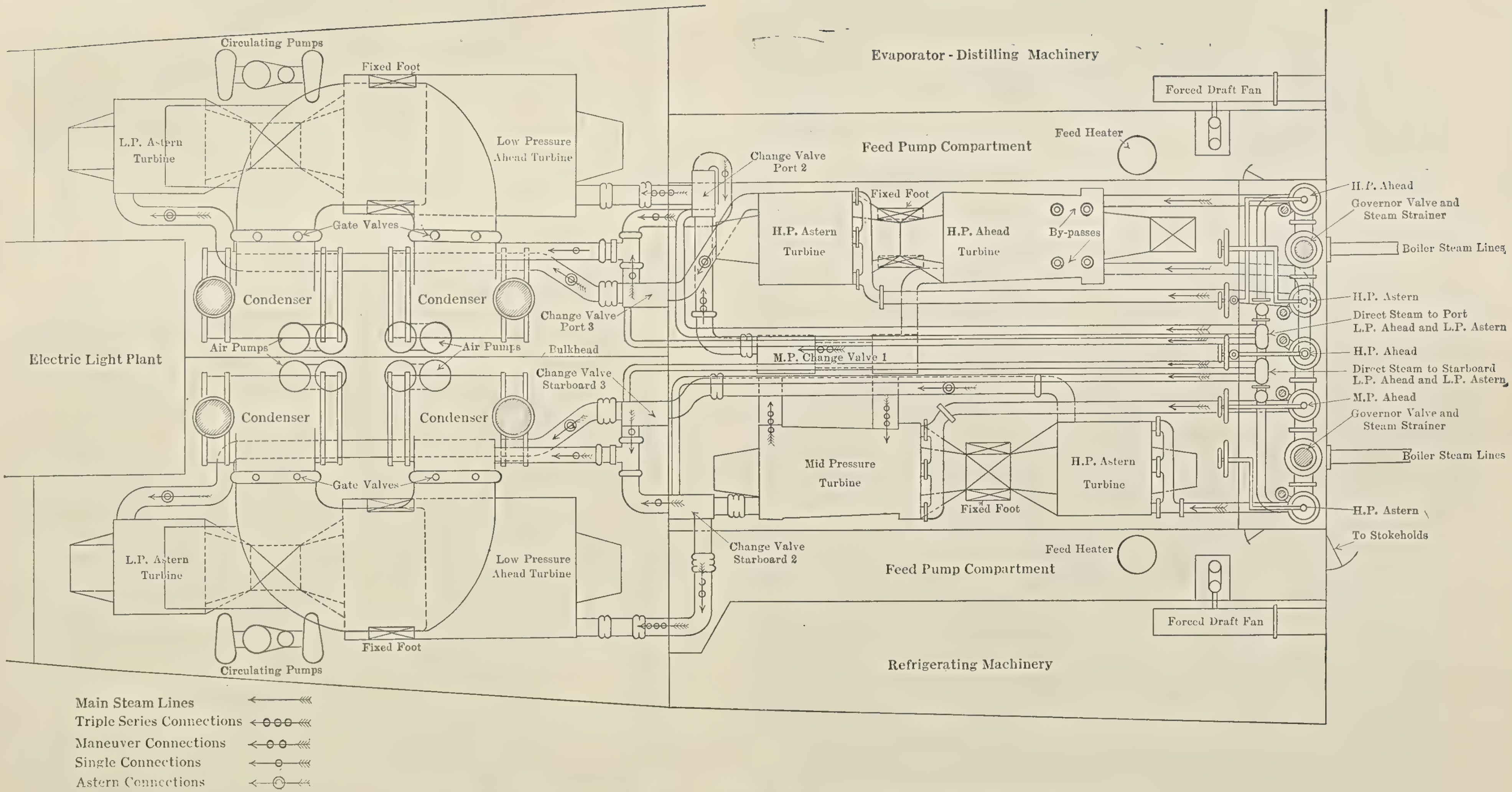


Fig. 2.—Diagram of the Engine Rooms of the *Leviathan,* Showing Steam and Exhaust Connections

The list, Table I, gives the principal dimensions of the vessel and also comparisons with other similar vessels.

General Arrangement of Turbine Machinery

The vessel is driven by the Parsons direct type of steam turbine arranged on four shafts. The turbine installation consists of eight separate turbines with their respective rotors.

The go-ahead units, of which there are four, each driving a separate shaft, are arranged to operate in triple series, which is the arrangement adopted in all the large Parsons turbine-driven vessels built after the completion of the Cunard liners *Lusitania* and *Mauretania* in 1907.

The go-astern units, of which there are also four, are arranged to operate in parallel and consist of two independent sets for the two port and two starboard shafts, each unit of which drives a separate shaft. In other words, each shaft with its propeller wheel is driven, respectively, by one go-ahead turbine and one go-astern turbine.

The machinery installation contains many clever features, the chief being that under any extraordinary conditions which may arise at sea it is possible to operate the two turbines to any one shaft entirely independent of the other units. This means that it is hardly possible for any contingency to arise whereby the turbine installation can be entirely disabled. Further, all the interconnecting valves and pipes between the turbines are located on the lower half of the casings. The design of these valves, together with the hydraulic operation of the valve pistons, is such that any change can be carried out at sea without having to shut down or stop the vessel for any appreciable length of time.

The turbines are arranged in three separate engine room compartments, as shown on Fig. 2. The four units of the two inboard shafts are in the main or forward engine room, while the two turbines of each outboard shaft are in the two aft engine rooms, these compartments being separated by the fore-and-aft bulkhead down the centerline of the vessel. The high-pressure ahead turbine drives the port inboard shaft, and coupled directly to the aft end of this is a high-pressure astern turbine. The mid-pressure ahead turbine drives the starboard inboard shaft, and coupled directly to the forward end of this unit is the other high-pressure astern turbine. The two low-pressure ahead and two low-pressure astern turbines drive the outboard shafts, each pair being arranged in one of the separate aft engine rooms.

The forward or main engine room is about 66 feet long by about 60 feet wide. The turbine compartment, however, is only 42 feet wide, while the feed pumps, feed heaters and other auxiliary machinery are arranged in two side compartments adjoining the turbines, each about 9 feet in width. The maneuvering valves and gage board are located at the forward end of this engine room, the working platform and main floor is directly over the turbines, and nothing is visible of the turbines from this working platform.

The floor does not extend over the two side compartments, and this auxiliary machinery is exposed and can be seen always by the engineers in charge. On this platform or floor, and extending down the center line of the vessel, are located the forced lubrication pumps, oil coolers and oil strainers.

The turbine steam to gland connections, oil supply pipes and valves to the turbine bearings, and turbine drain valves are all operated from manifolds arranged on this platform, and at the aft end the engine room elevator also opens on to this floor. Directly under this platform gratings are arranged, so that access to the rotor bearings and thrusts, and dummy micrometer of high-pressure ahead turbines can be reached quickly.

Floor plates are also provided above the double bottom, over the engine room bilges, so that the oil drain pipes to the drain tanks are visible. There is also plenty of clear space to allow access to the drain connections under the barrels of the turbine casings.

The wing turbine compartments extend clear across the full width of the vessel and are about 80 feet in length. No regular platform or floor is arranged in these engine rooms, but at the same level as the floor of the forward engine room gratings extend right round the outboard sides of the turbines.

Access to the turbine rotor bearings and thrusts is provided for by means of ladders. The air pumps and line shaft bearings of the inboard shafts are also reached by means of a ladder and passageway, arranged beside the entrance door to the aft engine rooms, and on the starboard side this passageway permits of access to the main dynamo compartments.

Under the regular full-speed-ahead steaming conditions the steam from all the boilers is admitted to the high-pressure ahead turbine, out of which it passes over to the mid-pressure, and from the exhaust end of this unit it is divided and passes into the two low-pressure ahead turbines, and from these to the four main condensers.

For go-astern conditions the boiler steam is admitted to each of the high-pressure astern units, from which it passes over to the low-pressure astern turbines, thence to the main condensers, that is, the port high-pressure astern exhausts to the port low-pressure astern, and the starboard high-pressure astern to the starboard low-pressure astern.

Under maneuvering conditions, such as when entering or leaving port, the two ahead turbines driving the two port shafts and the two ahead turbines of the starboard shafts are operated independently, in which case the mid-pressure turbine takes boiler steam directly.

There are four main condensers of Weir's "Uniflux" design, which have a total cooling surface of 68,700 square feet, two being placed back to back in each aft engine room, on the inboard side of the low-pressure ahead turbines. The centrifugal pumps, each pair being driven by one compound reciprocating engine, supply the cold sea water to the two condensers of each engine room. Directly under the condensers there are two single-acting air pumps of Weir's "Dual" type in each engine room, which discharge to the hot well tanks.

Eight Weir's type of "Simplex" double-acting feed pumps draw water from the hot well tanks and reserve feed water tanks and discharge to the boilers, after passing the water through surface feed heaters using auxiliary exhaust steam.

Six vertical "Duplex" forced lubrication pumps supply oil to the turbine bearings and thrusts. The two oil coolers are of the double-tube condenser type, the cooling water passing outside the outer tube and internally through the inner tube, while the heated oil passes in a film between the two tubes.

In each aft engine room is also arranged an auxiliary condenser having about 21,000 square feet of cooling surface, together with its circulating water pump and monotype air pump.

A large evaporating and distilling plant is located in a compartment on the port side, outboard of the main turbine engine room, and correspondingly on the starboard side is the refrigeration machinery.

The main electric lighting plant is arranged in a space aft of the two large wing engine rooms and consists of five Brown-Boveri impulse wheel turbo-generators, each rated at 445 kilowatts and 110 volts. This compartment forms a portion of the tunnel for the two inboard lines of shafting and is about 30 feet wide and 66 feet long. An emergency electric light plant having a Diesel oil engine-driven generator is fitted well above the waterline and located close to the engineers' quarters.

TABLE II.—DIMENSIONS, TYPE AND SIZE OF PUMPS

Name	Type	No. Off.	Dimensions	Strokes per minute
Main air pumps	Weir, dual single steam cylinder	4	$\frac{21.26'' \times 2 \times 39.37''}{24.60''}$	16
Main circulating pumps	2 comp. recipg. engines combined with pumps. Branches about 39 inches diameter.	4	$\frac{18.50'' \times 31.89''}{19.68''}$ Impeller 59.06 inches diameter.	
Auxiliary circulating pumps	Single cylinder engine and pump. Branches 10 inches diameter.	2	$\frac{8.66''}{8.66''}$ Impeller 41.34 inches diameter.	
Auxiliary air pump	Monotype		$\frac{10.23'' \times 21.26''}{11.81''}$	40
Main feed pumps	Weir, single cylinder, double-acting vertical	8	$\frac{19.68'' \times 13.78''}{31.50''}$	20
Auxiliary feed pumps	Vertical duplex double-acting	4	$\frac{15.75'' \times 9.84''}{17.72''}$	34
Feed heater pumps	Weir, single cylinder, double-acting vertical	8	$\frac{19.68'' \times 13.78''}{31.50''}$	20
Oil pumps	Vertical duplex, double-acting	8	$\frac{11.02'' \times 8.68''}{12''}$	16.50
Bilge pumps	Vertical duplex, double-acting	4	$\frac{90.55'' \times 10.24''}{13.78''}$	32
Ballast pumps	Vertical duplex, double-acting	4	$\frac{11.81'' \times 11.81''}{13.78''}$	34
Ash ejector pumps	Vertical duplex, double-acting	4	$\frac{15.75'' \times 9.84''}{17.72''}$	34
Bath pumps	Vertical duplex, double-acting	2	$\frac{14.17'' \times 11.81''}{13.78''}$	
Sanitary pumps	Vertical duplex, double-acting	4	$\frac{14.17'' \times 11.81''}{13.78''}$	34
Drinking water pumps	Vertical single double-acting	2	$\frac{9.84'' \times 8.66''}{9.84''}$	55
Evaporator pumps	Vertical duplex, double acting	2	$\frac{5.98'' \times 5.98''}{5.90''}$	15
Hold pumps		4	$\frac{6.97'' \times 6.97''}{6.97''}$	
Brine pumps	Vertical duplex, double-acting	4	$\frac{6.69'' \times 6.69''}{7.87''}$	
Circulating pumps	Motor drive centrifugal type	2	In refrigerating machinery compartment at F. E. room	

The tunnel shafts are hollow, about 18⅜ inches external diameter, and the tail shafts 19⅝ inches external diameter. The two inboard lines of shafting are made up of nine lengths, which are supported by eighteen shaft bearings. The outboard lines of shafting each have three lengths, with six shaft bearings. The list, Table II, gives the leading dimensions of the various pumps.

DETAILS OF THE TURBINES

High-Pressure Ahead (Port Inboard Shaft).—The body of the casing is made of cast steel, built in four sections, with a permanent vertical joint arranged between the second and third expansion stages, while the two halves are bolted together at flanges on the horizontal centerline.

The diameter of the rotor is about 8 feet 8 inches and is made up of three separate forged steel drums which have internal flanges and are bolted together. The two end sections of the drum have other internal flanges at the end of turned cylinders, into which are fitted the rotor end disks, and these are in turn secured by through-bolts. The overall length of the rotor drum, including dummy, is approximately 18 feet.

There are 101 rows of standard impulse-reaction blades in casing and rotor respectively, arranged in four expansion stages, with blade heights varying from 3⅛ inches to 6⅜ inches. The Parsons type of contact dummy is fitted at the steam inlet belt, and the fore-and-aft clearance between the casing and rotor is measured by the usual micrometer. Two steam pipes, each 18⅛ inches diameter, admit steam to the turbine, and the exhaust nozzle is about 42 inches diameter. The by-pass valves are fitted

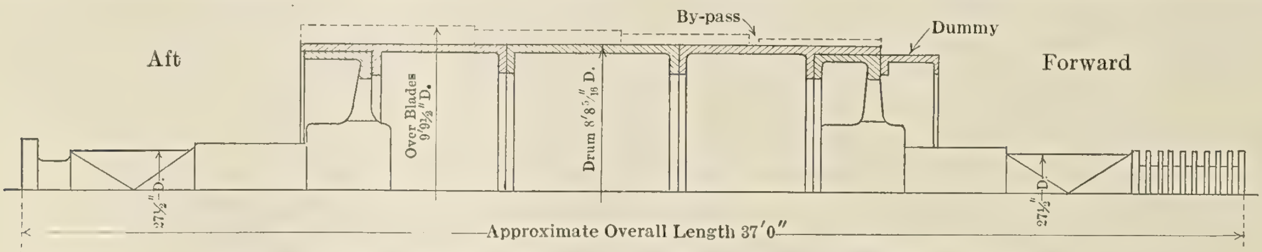


Fig. 3.—Half Section of High-Pressure Ahead Rotor. Approximate Weight, 80 Tons

between the first and second stages, which allow for an overload of about 25 percent above the designed power.

The rotor shafts are shrunk into the hubs of each disk, and the thrust collars for the rotor adjustment are arranged at the forward end of the rotor.

High-Pressure Astern (Port Inboard).—This casing is bolted rigidly to the aft end of the high-pressure ahead. steam inlet end, and this is followed by ten expansion stages of impulse-reaction blades on a drum construction, having a diameter of approximately 10 feet 10 inches. There are sixty rows of impulse-reaction blades in casing and rotor, the blade heights varying from 5½ inches to 13⅛ inches.

A radial fin type of dummy is fitted to the steam belt, and the overall length of the rotor drum is about 17 feet.

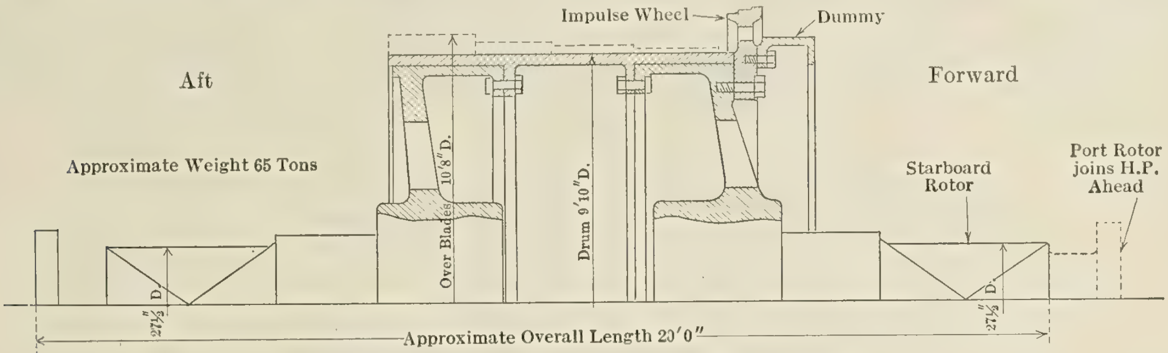


Fig. 4.—Half Section of High-Pressure Astern Rotor

The body is made of cast iron in two half-sections and bolted together at flanges on the horizontal centerline. An impulse wheel having three rows of rotor buckets, about 12 feet mean diameter, receives the steam from the regulator valves, and this is followed by four expansion stages of the regular impulse-reaction blading on a drum construction having a diameter of 9 feet 10 inches. There

When the mid-pressure ahead turbine is operating in triple series—that is, receiving exhaust steam from the high-pressure ahead—the impulse wheel is by-passed and the work done by the steam is entirely through the impulse-reaction drum blading. It is only when this turbine is being operated under "maneuvering" conditions that the impulse wheel buckets are in use, in which case

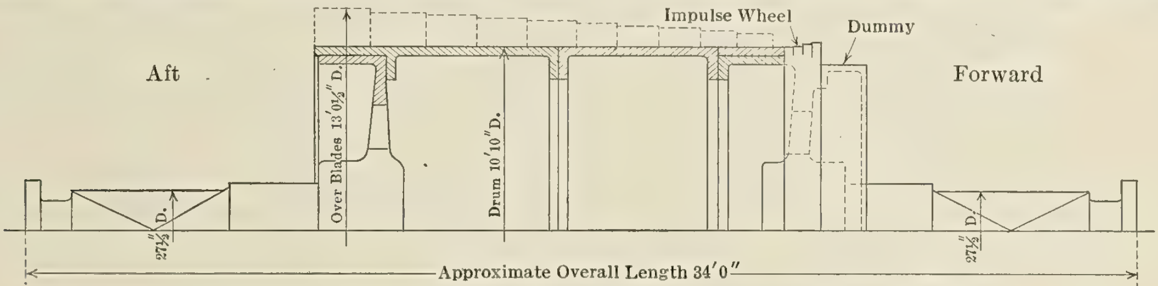


Fig. 5.—Half Section of Mid-Pressure Ahead Rotor. Approximate Weight, 100 Tons

are 42 rows of impulse-reaction blades in casing and rotor, with blade heights varying from 1 9/16 inches to 5 inches.

A radial fin type of dummy is fitted to the steam belt, and the overall length of the rotor drum is approximately 8 feet 6 inches.

Mid-Pressure Ahead and H. P. Astern (Starboard Inboard).—The casing of the mid-pressure turbine is built

the steam from the regulator valve passes into three sets of nozzles arranged in the top half casing.

Low-Pressure Ahead (Port and Starboard Outboard Shafts).—These casings are exceptionally large, made of cast iron and built up in a number of sections, and the two halves are bolted together at flanges on the horizontal centerline. The design of these turbines has this un-

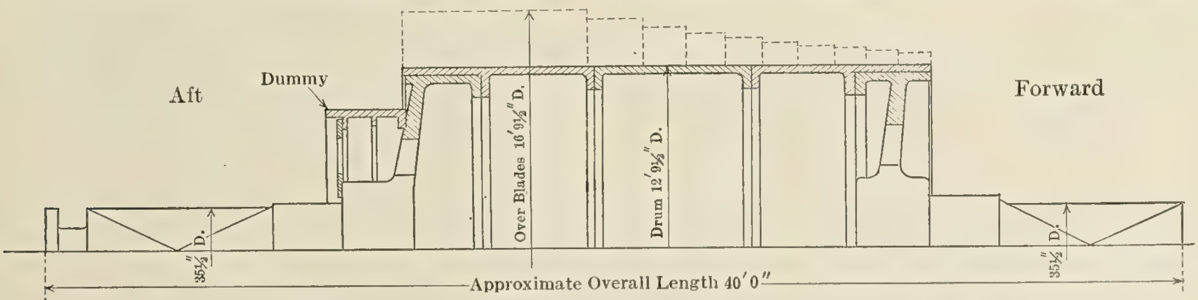


Fig. 6.—Half Section of Low-Pressure Ahead Rotor. Approximate Weight, 150 Tons

up in sections made of cast iron, and the two halves are bolted together at flanges on the horizontal centerline. The high-pressure astern turbine is bolted directly to the forward end of this unit and is similar to the high-pressure astern of the port inboard side.

The rotor has an impulse wheel with four rows of buckets about 11 feet 6 inches mean diameter at the

usual feature—the dummy is arranged at the aft end in the main exhaust belt. Consequently, the interior of the rotor is always full of steam at the pressure of the inlet belt, and this is done possibly to overcome any tendency of the rotor to distortion under varying conditions of temperature. The dummy is of the regular radial fin type.

The diameter of the rotor drum is 12 feet 9½ inches,

and it is made up of three forged steel drums bolted together at internal flanges. The end disks are also bolted to the drum with bolts. The overall length of the rotor drum and dummy is approximately 21 feet 3 inches.

There are sixty-three rows of impulse-reaction blades in casing and rotor, arranged in twelve expansion stages, the blade heights varying from 5¼ up to 24 inches. The internal diameter of the casing at the exhaust barrel is 16 feet 9½ inches.

Low-Pressure Astern (Port and Starboard Outboard Shafts).—These casings are bolted rigidly to the aft end of the low-pressure ahead. The body is made of cast iron built up in four sections, a vertical joint being arranged about the middle of the barrel, the pedestals which support the bearings, etc., being bolted to the casing and arranged so that they can slide in the aft direction. The diameter of the rotor drum is about 10 feet 10 inches and it is made up in two sections bolted together. The disk ends are bolted to internal flanges arranged at each end of the drum. The dummy at the steam inlet belt is of the radial fin type and the overall length of the drum is about 11 feet.

There are thirty-seven rows of impulse-reaction blades in casing and rotor, arranged in five expansion stages, with blade heights varying from 6 3/16 inches to 13⅜ inches in length.

Impulse-Reaction Blading.—The standard Parsons' blade sections are used throughout, the material being a common brass mixture, the groove widths varying from ½ inch to 1½ inches, the width of the blade section being dependent on the length of the blade. The usual method of fitting separate packing sections between each blade is adopted. About the center of the forward edge of each groove in casing and rotor a semicircular projection is left, and each blade and packing section is correspondingly notched out so as to fit over the projection. By this method each blade and packing section is held mechanically. The binding strips are of round brass wire, which is fitted in a hole drilled through the blades, and the wire is then silver soldered to each blade. In the long blades there are three rows of binding wires. The ends of all the blades are thin-tipped, in accordance with Parsons' usual practice.

Impulse-Wheel Buckets.—The composition buckets of the impulse wheels are fitted similarly to those of the reaction blading, that is, the buckets and the packing sections are separate. The method of holding them in the rotor grooves is, however, slightly different. The rectangular grooves of the rotor have semicircular projections on each side, and the buckets and sections are notched out to fit over these projections. To allow for fitting, at one place on the rotor rim the notches are cut out and the buckets and sections entered at this point and driven round. The tips of all the rotor buckets are thinned and no shroud strip is fitted, which is somewhat unusual.

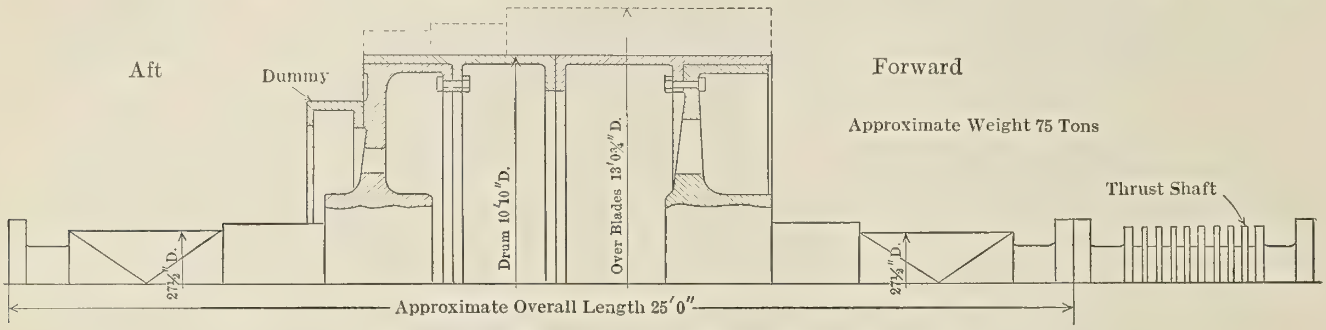


Fig. 7.—Half Section of Low-Pressure Astern Rotor

In the case of the high-pressure astern impulse-wheel buckets, the first and second rows are entirely unsupported, but the third row has a round wire threaded through each bucket and silver soldered; the widths of the buckets are about 1 inch, the lengths varying from 2⅛ inches to 3½ inches.

The mid-pressure rotor has four rows of buckets on the impulse wheel; the first row is entirely unsupported, the second and third rows have one round wire threaded through each bucket, and the last row has two round binding wires. The lengths of the buckets vary from 4 inches to 7½ inches and are about 1 3/16 inches in width.

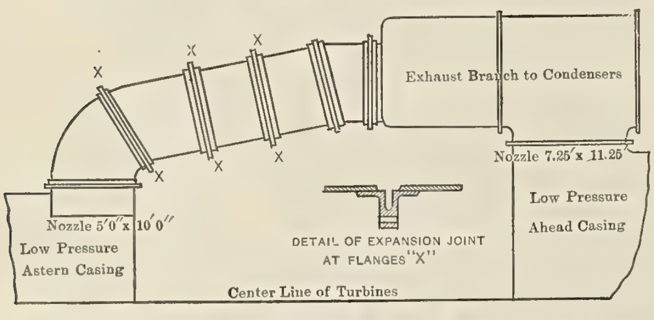


Fig. 8.—Side Elevation of Exhaust Arch Between Low-Pressure Astern and Nozzle to Condenser

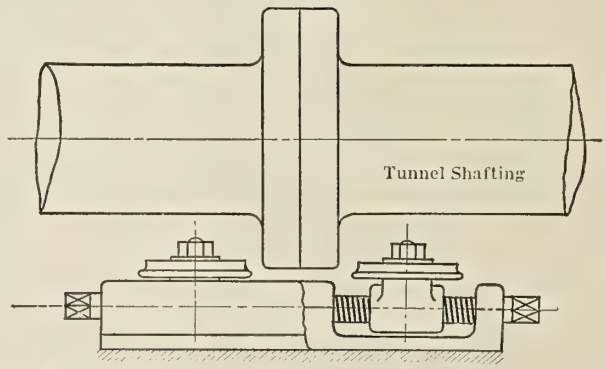


Fig. 9.—Sketch of Screw Roller Gear for Adjustment of Rotors

The Maneuvering Gear

The entire maneuvering of the turbine engines is carried out from the working platform of the forward engine room, the regulator valves being all arranged at the forward bulkhead.

Four lines of steam pipes pass the steam from the boilers over to the engine room—two on the port side and two on the starboard side. The stop valves connecting with these steam lines are in the engine room, and they are operated hydraulically. A cross-connection pipe runs

between the port and starboard valves. From each of these valves the steam passes into a steam strainer chest combined with an automatic trip valve, which has connections to the five main regulator valves of the turbines.

Interconnecting Pipes and Change Valves Between the Turbines.—The different ways in which the turbines can be operated and the means taken to do this have features of interest. Dealing with the high-pressure ahead, this unit can be operated in three different ways:

1. The exhaust steam can pass over to the mid-pressure turbine, as in "triple-series" connection.

2. It can exhaust directly to the port low-pressure ahead, as under "Maneuvering."

3. The exhaust steam can pass directly to the condensers of the port side.

The mid-pressure ahead turbine can be worked as follows:

1. Triple-series, receiving exhaust steam from the high-pressure ahead.

2. Maneuvering, live steam is admitted to the nozzles of the impulse wheel, passes through the reaction blades and over to starboard low-pressure ahead.

3. The exhaust steam can pass directly to the condensers of both port and starboard sets through the change valves on port and starboard side.

The high-pressure astern turbines of the inboard shafts can be used as follows:

The exhaust steam from each of these units can pass over to the low-pressure astern, or, for emergency conditions, change valves are installed, so that they can exhaust direct to the condensers. The exhaust pipe connections between the astern units are exceptionally long and about 29 inches in diameter. They are arranged on the lower half of the casings, and on the starboard side the length of this pipe is about 130 feet, and on the port side about 100 feet.

Main Turbine Repairs and Overhaul

At the time the vessel was taken over, the high-pressure ahead turbine casing was open. The rotor had also been lifted, and on examining the blading, dummy, glands and bearings it was soon seen that this engine was in perfect condition, and in a short time the rotor was lowered and the casing closed up for good.

The manhole on the aft end of the mid-pressure was opened up and a preliminary examination appeared to indicate that this engine was also in good working order.

The rows of impulse wheel buckets were exposed by

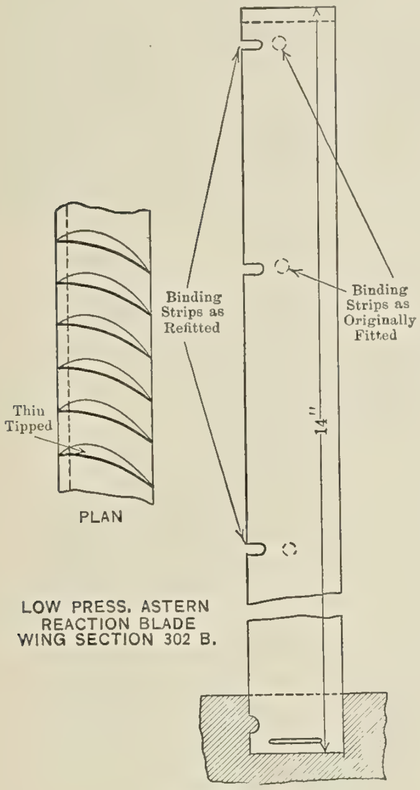


Fig. 10

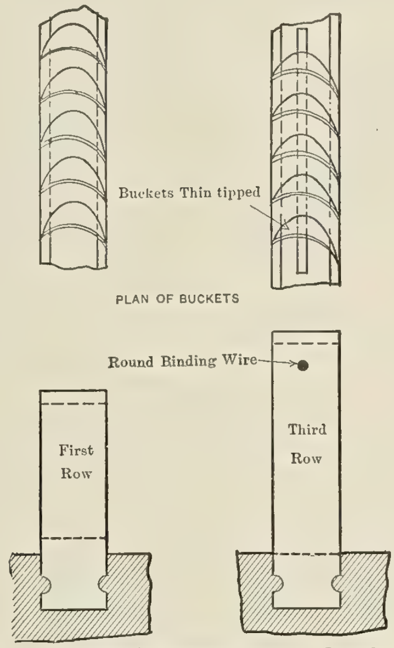


Fig. 11.—High-Pressure Astern Impulse Buckets

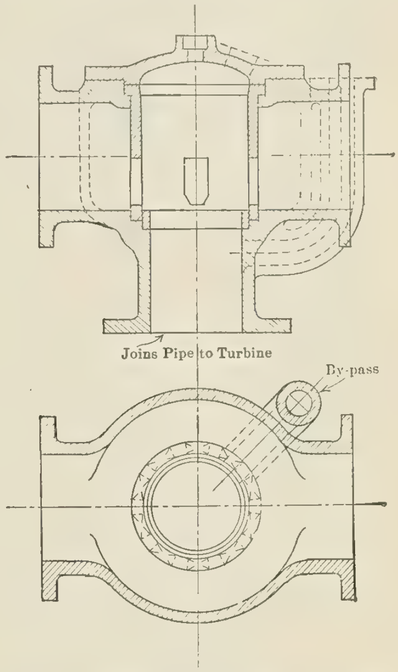


Fig. 12.—Sketch of Turbine Regulator Valve

opening a manhole on the upper half casing. Manholes arranged at each end of the low-pressure ahead turbines allowed me thoroughly to examine the end rows of blading, and this was all found to be in good order.

The safest course to follow as regards finding out the

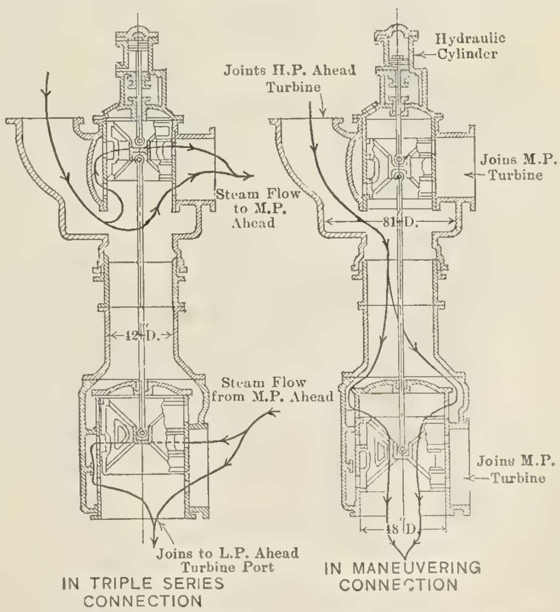


Fig. 13.—Mid-Pressure Turbine Change Valve

internal conditions of these three ahead turbines was to turn them with the turning gear in both ahead and astern direction and listen carefully for unseemly noises. Steps were taken to do this, but it was found that the cast-iron

brackets which support the various parts of the turning gear were badly fractured. Repairs were put in hand at once, and on July 10 the mid-pressure rotor was revolved in the ahead and astern directions and found to be in splendid working order.

The preliminary examination of the four astern turbines showed that a considerable amount of damage had occurred in the blading. Both high-pressure asterns showed damaged blading at the exhaust end rows, and in addition a pocket about 18 inches wide had been cut through ten rows of rotor blades and ten rows of the casing blades on the port turbine, and six pairs of rows on the starboard. The condition of the blading at the steam inlet end could not be seen until the upper half casing was lifted.

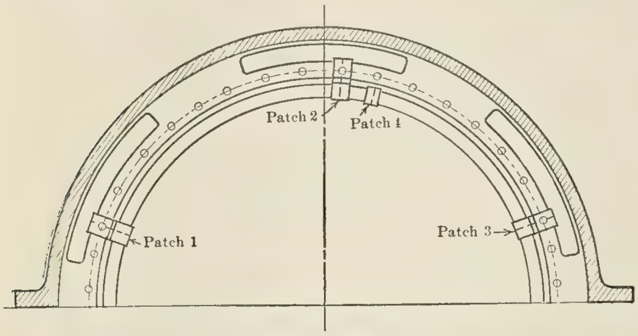


Fig. 14.—Section at Impulse Wheel Exhaust Belt Looking Forward

Both low-pressure asterns also showed that there was damaged blading at the steam inlet end and also at the exhaust end, and, in addition, pockets about 15 iuches wide had been cut through nine pairs of rows of blading in one case and seven in the other.

High-Pressure Astern (Port Inboard Shaft).—Upon lifting the top casing and rotor, the following conditions were noted:

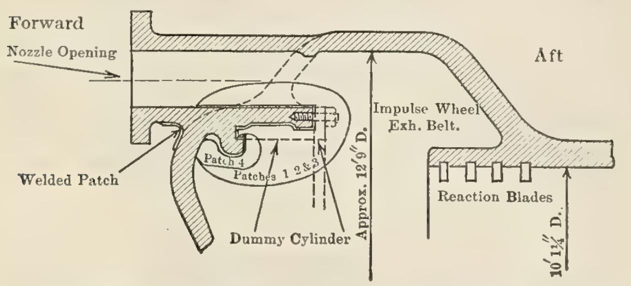


Fig. 15.—Approximate Section Through Nozzle Openings Showing Detail of Electric Weld Patches. Starboard H. P. Astern Cylinder Top Half

(*a*) The three rows of impulse wheel buckets of rotor were badly damaged and required to be entirely renewed.

(*b*) The cast-iron dummy cylinder had been removed, and this was found lying around badly fractured.

(*c*) The dummy piston of the rotor was seriously distorted, and pieces of the dummy cylinder and the brass fin strips had fused in lumps onto the surface of the piston.

(*d*) The four last rows of the rotor blades and three rows of top and bottom casings, together with the blading cut out in the pocket, all required renewal.

The following repairs were made.

A new cast-iron dummy cylinder was fitted. This was made in six pieces, three for the lower half and three for the upper.

Attempts were made to chip, file and grind the dummy piston of the rotor, but this was not satisfactory, and eventually this was machined and new dummy fin strips fitted. To machine the dummy piston, the rotor was lowered into place and connected up with the turning gear, a cut was taken across the surface and the grooves for the fin strip were turned out.

All the damaged blading at the exhaust end of rotor and casing was renewed, the total number of new blades being approximately 6,500.

After careful consideration it was deemed advisable not to refit the impulse wheel buckets, inasmuch as the indications tended to show that the blading troubles were caused by distortion of the impulse wheel under steaming conditions. Therefore the three rows of buckets in the rotor wheel were removed, together with the two segments of casing guide vanes, as well as the nozzles in the cast-steel chambers.

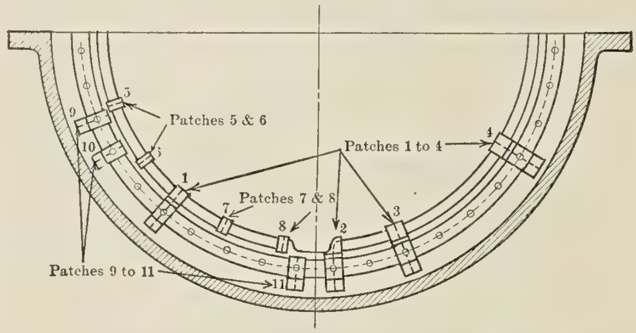


Fig. 16.—Section at Impulse Wheel Exhaust Belt Looking Forward

This turbine was opened up early in June and closed up on October 11, 1917.

Low-Pressure Astern (Port Outboard).—When this turbine was opened up the following blading repairs were found necessary:

Rotor.—(*a*) The first four rows and part of the fifth row at the steam inlet end were damaged. (*b*) First row of second expansion stage. (*c*) The last two rows at the exhaust end, together with a pocket 15 inches wide cut through nine rows of blades.

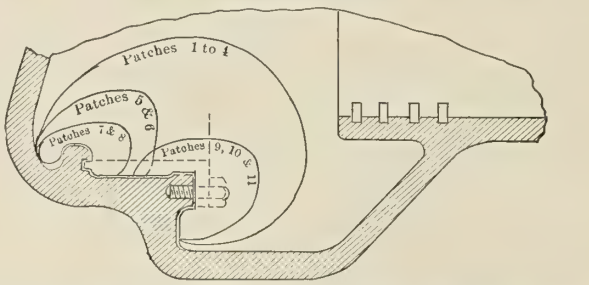


Fig. 17.—Approximate Section Across Impulse Wheel Exhaust Belt, Showing Detail of Electric Weld Patches. Starboard H. P. Astern Cylinder, Bottom Half

Lower half casing.—The first four rows of the steam inlet end and the first row of second expansion all badly damaged.

Top casing.—The first four rows at the steam inlet end, the first row at the second expansion, and part of the last two rows at the exhaust end were damaged. In addition to this, a pocket 15 inches wide was cut through eight rows of blades.

All this blading was refitted completely, amounting in all to about 13,500 blades and packing sections, and the turbine was closed up on September 25.

On October 7 this turbine was coupled up to the low-pressure ahead and both revolved by the turning gear in ahead and astern direction, and everything was found to be in order.

Low-Pressure Astern (Starboard Outboard): Rotor.—

(*a*) The first four rows at the steam inlet end and the last row at the exhaust end were badly damaged. (*b*) A pocket about 16 inches wide had been cut through the last seven rows of blades at the exhaust end.

Lower half casing.—The first four rows at the steam inlet end were badly damaged.

Top casing.—(*a*) The first three rows at the steam inlet end and last row at exhaust end were badly damaged. (*b*) A pocket about 16 inches wide had been cut through seven rows of blades.

All this blading was refitted, amounting to about 10,000 blades and packing sections.

This turbine was closed up on October 4, and on October 20 it had been coupled up to the low-pressure ahead and both revolved in ahead and astern directions satisfactorily.

High-Pressure Astern (Starboard Inboard).—When this casing was opened it was seen that very considerable repairs would be necessary to make this turbine work successfully:

(*a*) The three rows of the impulse wheel buckets of rotor were badly damaged.

(*b*) The dummy cylinder had been removed and the dummy piston showed clearly that it had been rubbing in contact with the dummy cylinder. Lumps of metal had fused onto the piston surface and it was badly distorted.

(*c*) The four last rows of rotor and casing blades were damaged and required renewal, together with a pocket 18 inches wide, which had been cut through six rows of rotor blades and six rows of casing blades in the lower half.

(*d*) The cast-iron casing was also found to have large cracks or fractures, which had undoubtedly been caused by the revolving dummy piston of rotor coming in contact with the dummy cylinder, which eventually fractured into a number of pieces. These pieces apparently jammed while the rotor was revolving, and finally resulted in fractures developing in the main casing walls.

Top casing.—(*a*) On the interior surfaces there were four fractures in all, three being in the nozzle openings. Fig. 14 shows the approximate position of the damage in the casing, and also the extent of the fractures.

(*b*) Externally, there were small cracks under the nozzle openings, in line with the internal fractures.

Lower casing.—In this half of the casing the damage was much greater and the question of making satisfactory repairs became a very serious matter.

(*a*) There were eleven internal fractures or cracks (see Figs. 16 and 17).

(*b*) Fractures 1 to 4 are somewhat similar to the three in the upper half; they extend from the facing to which the dummy cylinder is bolted right over to the dished end wall of the casing.

(*c*) Fractures 5 to 8 occurred in the wall which supports the end of the dummy cylinder and are similar to fracture 4 of the upper half casing.

(*d*) Fractures 9 to 11 are across the facing to which the dummy cylinder is bolted.

Around the external wall of the lower half casing eight bulb webs are arranged at equal distances and support the dished end of the casting. Seven of these were fractured completely through, and the damage extended into the main body of the cylinder wall.

The engineers had attempted to limit the extent of the fractures, for brass pegs had been fitted at the end of some of the cracks.

A drain facing on bottom of the turbine was also cracked at the base for about one-half of the circumference, and pegs had been fitted to each end of this fracture.

A small cofferdam was built up in the casing at the steam belt and filled up with water, but the water began to pour through to the outside, showing that the fractures extended through the full thickness of the casing wall, which is about 3½ inches thick.

Upon reporting the conditions to Capt. Earl P. Jessop, U. S. N., engineer officer at the New York Navy Yard, who was in charge of all the repairs in these ships, Mr. Jessop made a thorough examination of the casing and strongly advised electric welding the fractures. Mechanically fitted patches could not be fitted internally, because

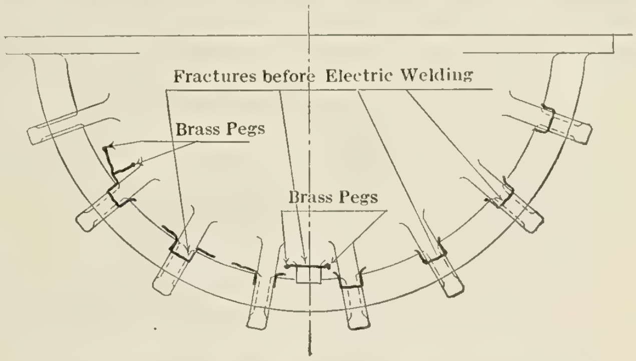


Fig. 18.—External End Elevation of Casing Looking Aft

the damage was all located in the casing where it supports the dummy cylinder. Mr. Wilson, of The Wilson Welder and Metals Company, also reported most favorably as regards bringing this work to a successful completion, and about the middle of July work was commenced on preparing the fractures for welding. This was carried out as follows:

Along the line of fracture a V-groove was chipped out. On either side of this groove ¾-inch diameter holes were drilled and tapped, into which were fitted steel studs, the

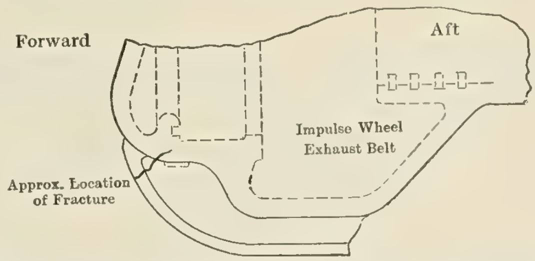


Fig. 19.—Approximate Side Elevation Showing Bulb Webs. Starboard H. P. Astern Cylinder, Lower Half

end of each projecting above the metal about ¼ inch to ⅜ inch. In most cases two rows of studs were fitted and staggered, the pitch being about 2¼ inches.

The welding material used was a steel alloy wire, about 3/16-inch diameter. The first layer was placed along the length of the fracture at the bottom of the V-groove. This layer was then peaned down; if found to be loose, it was cut out and the work begun over again. On top of this another layer was welded in and again peaned down, and this process was repeated until the weld was built clear round the studs and projected about ¼ inch above the surface of the adjoining cast iron.

After this work was completed the casing was tested under water pressure to about 100 pounds per square inch and found to be practically watertight. Before the new dummy cylinder could be fitted it was necessary to grind down the weld patches until they projected only about ⅛ inch above the faces of the adjoining wall, and the dummy cylinder castings were notched out to fit over the patches.

All the damaged reaction blades were replaced; this

amounted to about 8,000 new blades and packing sections, and the turbine was closed up on October 31.

Boilers

The boilers are arranged in four watertight compartments, three compartments having four groups with three boilers per row athwartships, while the forward compartment contains ten boilers, making a total of forty-six boilers in all. Coal bunkers are arranged in the wings at the sides of the boilers, separated by watertight compartments.

The boilers are of the Yarrow type, having one steam drum connecting through two groups of tubes to the lower drums, each boiler having three furnaces. The working pressure is 235 pounds per square inch gage, and the heating surface of the generating tubes is approximately 210,000 square feet. They are designed to work with Howden's forced draft, four large breast fans driven by compound reciprocating engines supplying the air.

The boilers were found to be in fair condition, and only two required to be re-tubed. The brickwork was renewed in a large number, and it was also found necessary to install new fire bars, so as to allow more air to pass through the fires.

General Overhaul

While the repairs to the main turbines were in progress, the auxiliary machinery was overhauled thoroughly; the four main condensers were water-tested, new tubes fitted to the auxiliary condensers, and new packing was fitted to the gland bushes of all reciprocating engines and steam cylinders of the auxiliaries. The main steam lines, as well as the auxiliary steam lines, were fitted with proper drains and traps. The forced lubrication system, including oil coolers, oil drain tanks and piping, was thoroughly cleaned. The line shaft bearings were removed and freed of all grit and dirt and the stern tube glands repacked.

Dock Trials

The preliminary steam trials of the turbines began early in November and were made with the turbines uncoupled from the line shafting. All the turbines were driven up to full-speed revolutions, namely, 180 per minute.

A slight hitch occurred with the starboard high-pressure astern. The regulator valve jammed open, resulting in the turbine gaining momentum rapidly. On shutting the bypass valve the steam pressure on top of the piston forced this down with a bang, and on opening out the valve it was found that the piston valve was fractured right around the metal which supports the valve stem. It is useless to speculate just when this fracture took place, but it is not improbable that it may explain why this turbine was damaged much more than the other units.

Sea Trials

The vessel left New York Harbor for extended trials on November 17 and returned on November 29. During that time various trials were carried out at cruising speeds and records of the coal consumed were made.

A short trial was made at full speed, the average revolutions of the four shafts being 171 per minute, corresponding to a speed of about 22.50 knots. No torsion meters were in use, but the estimated shaft horsepower amounted to about 65,000.

The main turbines worked splendidly throughout the whole series of the trials, and absolutely no adjustments had to be made. The engines maneuvered splendidly and the astern turbines did good work. Minor adjustments were made to some of the auxiliary machinery and to the steering gear, but, taking everything into account, the performance of the machinery was most satisfactory.

Buoyancy and Stability of Troop Transports*

Requirements for Safety of Troop Ships—Changes in Subdivision of Existing Vessels and Spacing of Bulkheads in New Designs

BY PROFESSOR WILLIAM HOVGAARD

As the number of troops on board a transport often greatly exceeds the number of passengers carried on a liner of the same size, this fact, in connection with the urgency and vital character of military expeditions in general, makes the problem of the safety of troop transports rank higher in importance than in the case of ordinary passenger steamers.

Requirements for Safety

In order to obtain a basis for the discussion, it is necessary to make certain assumptions as to the amount of damage which it may reasonably be stipulated that troop transports should be able to stand without their safety being imperilled. In addition to the ordinary dangers of navigation, notably collision and grounding, such vessels are in time of war exposed to attack from artillery, mines and torpedoes, but we consider here those dangers only in so far as they affect the buoyancy and stability, involving damage below the bulkhead deck. In this connection underwater explosions are the most important.

Evidently the minimum claim to buoyancy and stability of a troop transport is that they should stand the effect of one underwater explosion or one collision without sinking or capsizing. But this is not sufficient. In order to provide for roughness of the sea and allow the safe lowering of the boats, there must remain a certain margin of reserve buoyancy and the ship must not take a great list. Since an explosion or a collision is liable to damage one of the main transverse bulkheads, those requirements must be satisfied even if two adjoining compartments are flooded, whatever the conditions of loading. Finally, the spacing of the bulkheads should be such that there will be very little chance of two bulkheads being damaged by one explosion.

As explained hereafter, the claims stipulated above practically determine a minimum length of troop transports. It is at once clear, moreover, that in order to prevent a ship from taking an excessive list in the damaged condition, she must be subdivided essentially on the transverse system, and the metacentric height must not fall below a certain minimum dependent on the size and design of the ship and the condition of loading.

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1919.

Under this head we discuss the spacing of the transverse main bulkheads with special regard to the danger of foundering by bodily sinkage, eventually combined with longitudinal inclinations, which may cause the ship to go down by the bow or the stern. We disregard the presence of longitudinal bulkheads and the transverse inclinations which they may produce.

BUOYANCY

In case of ships for which all the design data, as well as the condition of loading, are accurately and completely known, the problem is relatively simple. The effects of bilging on draft and trim can be calculated by direct methods, all combinations of flooding of two or more compartments in accordance with the stipulated requirements being studied. There is, in fact, nothing in the problem which calls for an explantion beyond that already given in text-books on naval architecture. The difficulties arise when it is required on short notice to equip and use ships for transport service, such as ordinary transoceanic steamers, about which only incomplete information is at hand and where circumstances do not allow time or opportunity for complete calculations. Such were the conditions in case of many passenger steamers taken over in 1917 by the United States Navy for use as troop transports, especially the German vessels, for which in general no line drawings, general arrangement plans, or weight statements were available. In all such cases it is necessary to resort to approximate methods of investigation.

Specific problems as to the effect of flooding of certain compartments may be solved directly by rough calculations, using approximate methods. In the *Leviathan,* for instance, it was found that flooding of all four engine rooms, together with adjacent side compartments, would produce a bodily sinkage of about 4 feet and a total change of trim by the stern of 14½ feet. In the *Mount Vernon* a similar state of bilging would produce a sinkage of 3¾ feet and a total change of trim by the stern of 11¼ feet. This mode of investigation, however, cannot be applied with advantage to all possible cases of flooding of one or more compartments in a ship, because it would involve an amount of labor that would hardly be warranted, in view of the crudeness of the available data as here assumed. A more general and simple method is needed when it is required to deal with a great number of ships in a short time, in which case broad, comparative results are of more interest than absolute quantitative values.

We shall here briefly describe the so-called "floodable-length" method devised by the Committee on Subdivision of Merchant Ships, appointed by the British Board of Trade.* This method enables a designer with relatively small work to study the spacing of the bulkheads in a new ship with a view to the fulfillment of given requirements as to subdivision, and provides a ready means of determining the status in this respect of an existing ship, giving a measure of its safety as well as suggestions for eventual alterations in the watertight subdivision.

THE FLOODABLE-LENGTH METHOD

In principle the method consists in determining the "floodable length" at any point in a ship, being the length of hold, having its center at that point, which can be flooded without the ship foundering. The spacing of the bulkheads is expressed as a fraction of the floodable length obtained by multiplying it with a "factor of subdivision." If that factor is everywhere equal to or smaller than unity, but still greater than one-half, any one, but not any two, compartments may be flooded without the ship going down, and we have what is commonly called a "one-compartment" ship. If the factor is everywhere equal to or smaller than one-half, but still greater than one-third, any two, but not any three, adjoining compartments may be flooded without the ship going down, and we have a "two-compartment" ship, and so forth.

The floodable length is found as described in Vol. I of the Report of the Committee, while Vol. II gives a number of diagrams from which it may be obtained directly, expressed as a percentage of the length of the ship. The so-called "margin-line" forms the basis of the calculation. It is drawn 3 inches below the deck-at-side line of the bulkhead deck, the latter being defined as the uppermost continuous deck to which all transverse watertight bulkheads are carried. The floodable length is so determined that when that length of the hold is flooded the ship shall not be submerged beyond the margin line.

Various elements are used as arguments in the diagrams of Vol. II for finding the floodable length, the most important being the freeboard ratio, which is the ratio between the freeboard to the margin line amidships and the draft amidships. Greater freeboard at the ends is taken into account by the sheer ratio, which is the ratio of the sheer of the margin line at the forward or after

GENERAL CHARACTERISTICS OF SHIP

	Light	Loaded
Length overall	545.6′	
Length between perpendiculars	524.′	
Beam molded	60.′	
Draft amidship	19.5′	27.′
Freeboard to margin line	18.25′	10.75′
Displacement, tons	12,571	18,143
Depth to margin line amidShip	37.75′	37.75′

	Light	Loaded
Freeboard ratio	93.5	.398
Sheer ratio for'd	.462	.333
Sheer ratio aft	.144	.103
Block coefficient	.718	.746
Permeability of space for'd of boiler rooms	87.8%	67.2%
Permeability of machinery space	80. %	80. %
Permeability of space aft of engine room	85.2%	67. %

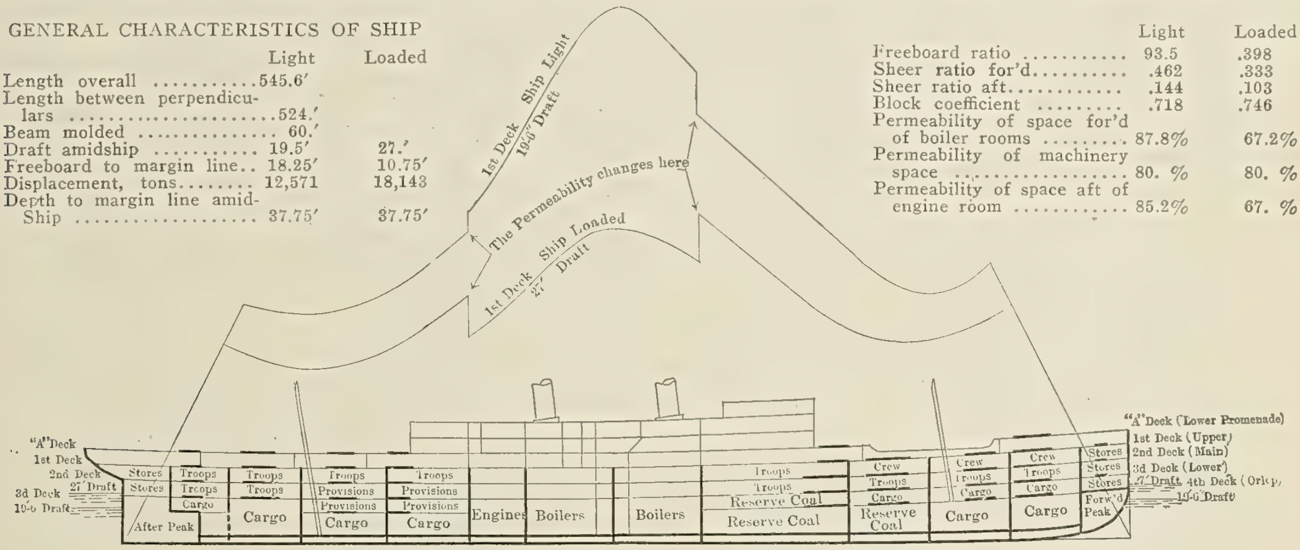


Fig. 1.—Curves of Floodable Length

* The provisions of the International Convention for the Safety of Life at Sea relating to Safety of Construction of Ships are in substantial agreement with the results of the investigations of this committee, which made its report in November, 1914.

end to the draft amidships, the sheer being measured from the horizontal line through the lowest point of the margin line. The element next in importance is the permeability, which is the percentage of a given space that can be occupied by water. When a ship is in the light condition, the high permeability of the empty hold spaces to some extent neutralizes the favorable effect of the greater freeboard, but nevertheless the floodable length is ordinarily much greater than in the full-load condition. Exceptionally the floodable length in the light condition may fall below that in the full-load condition at the ends. The numerical value of the permeability should be calculated very carefully, as it exerts a great influence on the result. The diagrams in Vol. II of the Report are prepared for permeabilities of 60 and 100 percent. The floodable length for other permeabilities must be obtained by interpolation. The form of the hull is taken into account by using the block coefficient as one of the arguments in the diagrams, which are calculated for a standard form of various degrees of fineness. If ships differ materially from the standard form, certain corrections must be applied.

When the floodable length is obtained for a number of stations in a given ship or design, the results are marked up as ordinates from the base line of a profile drawing, which shows the location of the bulkheads, and a "floodable-length curve" is drawn through the points so obtained, giving, together with the bulkheads, a graphical representation of the safety of the ship in damaged condition.

In Fig. 1 such curves are given for one of the ex-German ships used as a troop transport during the war. The lower curve corresponds to the full load, the upper to the light condition.

All floodable-length curves are characterized by a maximum amidships, a minimum on about one-quarter of the length from each end, and a pronounced rise towards the ends of the ship.

The floodable-length method, being applicable to all sizes and types of vessels, cannot, of course, be expected to give accurate results in any specific case. Nor is this claimed for it; but, used intelligently, it affords a valuable means of dealing in a practical and comparatively simple manner with problems relating to the spacing of bulkheads. It enables the naval architect to judge whether a given ship is suitable for use as a troop transport and to determine what alterations, if any, should be made in it to improve the safety. It was applied to all vessels used as transatlantic troop transports by the United States Navy during the war, and showed that all the ex-German ships when in the light condition were two-compartment ships, many of them with an ample margin, and some approached or reached the three-compartment standard. In the full-load condition most of those vessels came up to the two-compartment standard.

Changes in the Subdivision of Existing Ships

In cases of emergency, ships may have to be used which are far from satisfactory in point of subdivision, but it must be borne in mind that other qualities have also to be considered. High speed and good maneuvering capability, which materially reduce the dangers of attack by submarines, may outweigh defects in subdivision. A well-subdivided but slow vessel may be more exposed to destruction by submarines, than a poorly subdivided but faster vessel. Also the accommodations immediately available in a ship for carrying troops have to be considered.

If the subdivision of an existing ship is found unsatisfactory, conditions may be often materially improved by carrying one or more bulkheads up to the deck next above the bulkhead deck. This applies in particular to ships where non-watertight bulkheads, which can be readily made watertight, exist above the bulkhead deck as extension of some of the main bulkheads. The addition of one or a small number of new watertight bulkheads and slight modifications of bulkheads already existing above the bulkhead deck will be then sufficient to raise the bulkhead deck for the whole or part of the length of the ship, and the safety may be thus immensely increased. In some cases the subdivision below the bulkhead deck may with advantage be supplemented by additional bulkheads. Alterations of this nature were made by the Bureau of Construction and Repair in a number of transports, but, on account of the urgency of the service and the short stay in port of the vessels, no extensive changes could be carried out.

Spacing of Bulkheads in New Design

The claim stipulated above that a troop transport should be able to stand the effect of one underwater explosion determines the two-compartment standard as the minimum requirement, but where the size of a ship allows a higher standard to be reached the designer should, of course, take advantage of this fact, even when that standard cannot be maintained throughout the entire length of the ship.

In determining the spacing, the designer must take into account the probable extent of the damage, the probability of bulkheads being lost, and the effects on the buoyancy. He must consider also the limitations imposed by the size and length of the ship, as well as by the general requirements of the service. We shall take up each of these questions separately.

(*a*) The first thing to consider is the horizontal extent of the zone of rupture and deformation caused by the explosion of a mine or torpedo, in so far as those effects destroy the integrity of the bulkhead. Its value varies greatly with the size of the charge and with various other conditions, but seems to lie between 25 and 55 feet. We shall denote this quantity by e and assume that under present conditions its probable highest average value is 35 feet. This is but slightly smaller than the figure adopted by Mr. W. S. Abell, chief ship surveyor of Lloyd's Register of Shipping, in a paper read before the Royal Society, January 22, 1919, discussing the same subject for cargo vessels.

(*b*) There is for every part of a ship a lower limit to the spacing of the bulkheads, determined with regard to proper housing and working of the machinery, the service of the ship, the accommodation of the troops, and the stowage and handling of cargo, as well as the proper utilization of space in general. In the forward and after holds, excepting the extreme end compartments, the spacing seldom falls below 35 feet in practice, and probably 40 feet may be considered as the smallest desirable spacing of the bulkheads in those parts of the ship. In the midship portion, where the machinery is located, it is often necessary to make the compartments much larger, especially in ships like troop transports which have or should have great engine power.

(*c*) If the spacing of the bulkheads is equal to e, the extent of the damage caused by an explosion, it is likely that an attack would always injure at least one bulkhead, but by increasing the spacing beyond this limit even by a very moderate amount, the probability of a bulkhead being lost is very much reduced. Let the spacing be s, then this probability, which we shall call c, is measured by the ratio between the danger space, e, and the remaining

space, $s - e$, in each compartment. Hence,

$$c = \frac{e}{s - e}. \qquad (1)$$

When $s = e$, we have $c = \infty$, but when s is 20 percent greater than e, $c = 5$, that is, the chances are only 5 to 1 that a bulkhead will be lost by a single explosion.

Based on these considerations, it is proposed in troop transports to adopt a minimum spacing of the bulkheads $S_0 = 45$ feet, which gives a maximum value of the probability factor:

$$c_0 = \frac{35}{45 - 35} = 3.5.$$

(*d*) In order to secure the two-compartment standard, the combined length of any two adjacent compartments must in no case exceed the floodable length, f, and should in general be slightly smaller. Hence,

$$2S \underset{<}{=} f, \qquad (2)$$

and the smallest permissible floodable length will be

$$f_0 \underset{>}{=} 2S_0, \text{ or} \qquad (3)$$
$$f_0 \underset{<}{=} 90 \text{ feet.}$$

When the floodable length at any point is so great as to admit of a subdivision into three compartments, each of which has a length greater than S_0, the three-compartment standard should be adopted in that region if practicable. In such a case no single explosion is likely to flood a greater length than $\frac{2}{3}f$, and a margin of safety will remain, which enables the ship to sustain further damage without sinking. A similar procedure may be followed where practicable in cases where $f > 4S_0$, resulting in a still greated margin of safety.

(*e*) If we take into account not only the direct effects of flooding, but the probability of a bulkhead being lost, there is a limit to the closeness of spacing of bulkheads, which it is not profitable to pass. In other words, contrary to what might appear at first sight, it is not always advantageous from the point of view of safety to space the bulkheads closer together.

Consider first a one-compartment ship, where the loss of a bulkhead means the loss of the ship. If the spacing is here made equal to e, there is a practical certainty that the ship will go down if she is hit by a torpedo. If the spacing is 45 feet—that is, $S = S_0$—we have seen that the probability of a bulkhead being lost is as 3.5 to 1. Suppose now that the floodable length is 90 feet, the limiting value for the one-compartment standard, then by making $S = 90$ feet the probability of a bulkhead, and hence of the ship, being lost is reduced to

$$c = \frac{35}{90 - 35} = 0.64.$$

In general, the greatest safety within the one-compartment standard—that is, for $f \underset{<}{=} 2S_0$, is evidently attained by making the spacing equal to or slightly smaller than the floodable length.

Suppose, next, that a ship is designed to the two-compartment standard and that, consequently,

$$2S_0 < f < 3S_0,$$

or, with the value of S_0 here adopted,

$$90 \text{ feet} < f < 135 \text{ feet.}$$

With a spacing of $S = S_0 = 45$ feet, we have again the probability of a bulkhead being lost: —$c = 3.5$; but gradually, as S is increased, c will fall off, until in the limit when f is equal to 135 feet and S equal to, say, 65 feet, we have

$$c = \frac{35}{65 - 35} = 1.17,$$

that is, the chance of a bulkhead being lost is one-third of what it would be with $S = 45$ feet. This advantage of the wider spacing is believed to outweigh the drawback that when a bulkhead is lost and two compartments flooded there will be a smaller margin of safety than with the shorter spacing. Hence it is best in a two-compartment ship always to make the spacing approach one-half of the floodable length.

When $f > 3S_0$, or $f > 135$ feet, the three-compartment standard can be attained. Suppose that

$$135 \text{ feet} < f < 180 \text{ feet,}$$

then the best result is attained within the three-compartment standard by making S equal to or closely approaching $\frac{f}{3}$, in which case the probability of a bulkhead being lost will range from 3.5 to 1.4. It might be argued that it would be better to retain the two-compartment standard and make $S = \frac{f}{2}$, since then the value of c would be much reduced and would range from 1.08 to 0.64, but in that case the hold compartments would be unnecessarily, perhaps inconveniently, large, and when a bulkhead was lost the flooded length would be 50 percent greater than with the three-compartment ship. It is to be borne in mind also that a three-compartment ship is better able to stand underwater damage caused by collision or gunfire, which is not so liable to destroy the bulkheads. Hence, when f is greater than $3S_0$ and smaller than $4S_0$, the three-compartment standard should be adopted with S equal to or slightly smaller than $\frac{f}{3}$.

It is clear that the same reasoning will apply and an analogous conclusion will be reached when the floodable length is greater than $4S_0$ and we arrive at the following general rules:

1. The standard of subdivision should be the highest consistent with the floodable length and with the adopted minimum spacing of the bulkheads. If $nS_0 < f < (n + 1) S_0$, the n-compartment standard should be adopted.

2. Within the given standard of subdivision, the spacing of the bulkheads should be the greatest possible consistent with that standard, provided no practical considerations stand in the way of such spacing. With the n-compartment standard the spacing should closely approach $\frac{f}{n}$. In other words, the factor of subdivision according to this rule is practically either unity or some simple fraction: ½, ⅓, ¼, etc. It should be observed that the same ship may be subdivided to different standards, depending on the value of the floodable length at various points. Frequently ships which may be subdivided to the three-compartment standard at amidships and at the extreme ends can be subdivided only to the two compartment standard on the quarter length, where the floodable length is a minimum, and such vessels will be referred to as two-compartment ships.

(*f*) In troop transports which are liable to be loaded more deeply than ordinary passenger vessels, the floodable

lengths are relatively small. In the following table are given the average minimum values of f as found in troop transports of good design used during the war by the United States Navy. The minima occurred as usual on about one-quarter of the length of the ships from the ends. In the third column are given what are considered appropriate values for the corresponding spacing of the bulkheads at the points when the floodable length is a minimum.

Table I

Length of ship, L	Minimum floodable length, f	Spacing of bulkheads, s	Standard of subdivision
Feet	*Feet*	*Feet*	
400	70	65	One-compartment
500	90	45	Two-compartment
600	110	50—55	Two-compartment
700	125	60	Two-compartment
900	160	50	Three-compartment

Ships of less than 500 feet in length cannot, according to this table, be subdivided in a satisfactory manner to the two-compartment standard throughout their length and are not, therefore, suitable for the transport of troops. Ships of more than 500 feet in length may be subdivided according to the two-compartment standard and may reach the three-compartment standard amidships, but the latter standard can probably not be attained throughout and to full advantage in ships of less than 800 or 900 feet in length. Higher standards relative to the length of the ship may be attained, but only by carrying the bulkheads up to a rather unusual height or by a reduction in the carrying capacity of the ship; that is, by a disproportionate height of freeboard of the bulkhead deck and a low draft. One-compartment ships may, of course, be employed for the transport of troops in an emergency, but should ordinarily be used only as supply vessels or other auxiliary duty.

Differences of opinion will no doubt exist as to the numerical values to be adopted for the probable extent of damage by an explosion, the practicable minimum spacing of bulkheads and the assumptions on which the floodable lengths should be calculated, but this does not affect the soundness of the principles here stated. The main results of the investigation, as relating to troop transports for ocean service and on the present standpoint of submarine weapons, may be summarized as follows:

1. Troop transports should have a length of not less than about 500 feet.

2. The freeboard of the bulkhead deck and the sheer should be such that when the ship is on her deepest draft, and with reasonable assumptions as to permeability, she will conform at least to the two-compartment standard throughout her length.

3. Excepting the extreme ends of the ship, the spacing of transverse main bulkheads should not in general be less than about 45 feet.

4. Whichever standard of subdivision is adopted, the spacing of the bulkheads at any point of the ship should be the greatest practicable consistent with that standard.

(*To be concluded.*)

(*Photograph copyright by International Film Service, Inc., N. Y.*)

Battleship *Virginia* Floating into the Big South Boston Drydock, the Largest in the United States, and One of the Largest in the World. The Dock, Built by the State of Massachusetts, Was Taken Over by the Navy Department and Was Formally Opened Early This Month

Electric and Oxy-Acetylene Welding at the Bethlehem Fore River Shipyard

WHILE the welding department is one of the youngest of the departments at the Fore River plant of the Bethlehem Shipbuilding Corporation, yet it is one of the most interesting. Its duties up to within a year or so ago consisted chiefly in acetylene burning and cutting, and minor welding jobs, most of which were connected with machine repairs. Since the war, however, with the wonderful development and increased application of the electric welding process, operations of this department today affect nearly all of the departments in the plant.

While the advantages of the application of welding in shipyards are not fully recognized, the items mentioned in this article show how extensively many departments of this plant, at least are finding this process a time and money-saving proposition.

As the plates and shapes are brought into the ship shed to be layed off from the molds, the welding department begins its operations. Burners cut the openings in the plates for doors and hatches, trim the edges to the curves and lines laid out from the molds, burn out the lightening holes, and make other cuts that are impossible or more expensive to make with the shears and punches.

Fig. 1.—Burning

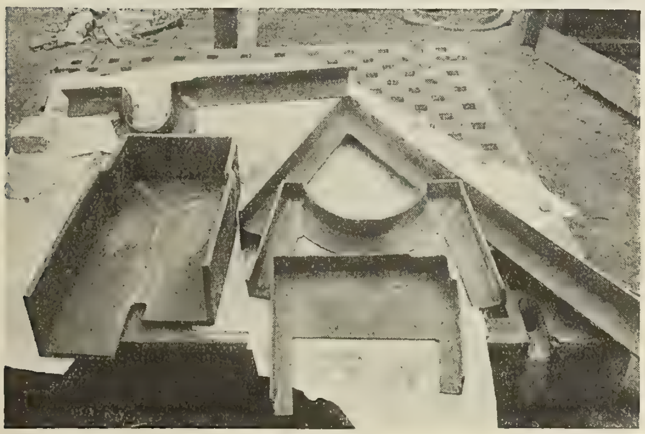


Fig. 2.—Anglesmith Inserts

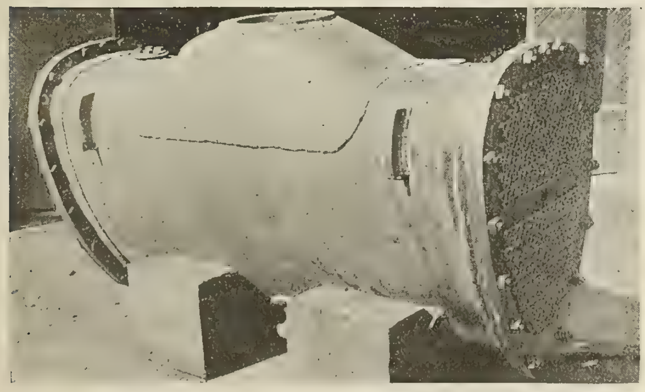


Fig. 3.—Destroyer Condenser Electric Welded

Smith Shop Work

In the smith shop the burners also cut holes in girders, notch angles and frames, split beams and work on innumerable pieces in conjunction with the smiths. Here also the welders join together gun foundation rings, blower trunks and smoke stack rings, add pieces to staples, etc. Boat davits and trolley supports split by the burner and bent into the required shape by the anglesmith are rapidly welded into solid pieces by the electric welder. Similarly, stiffening bars are split and welded, condenser frames are formed and false corners inserted and welded into solid pieces. Application is also made of spot welding machines to join elementary pieces, supplanting the use of rivets in some members entirely.

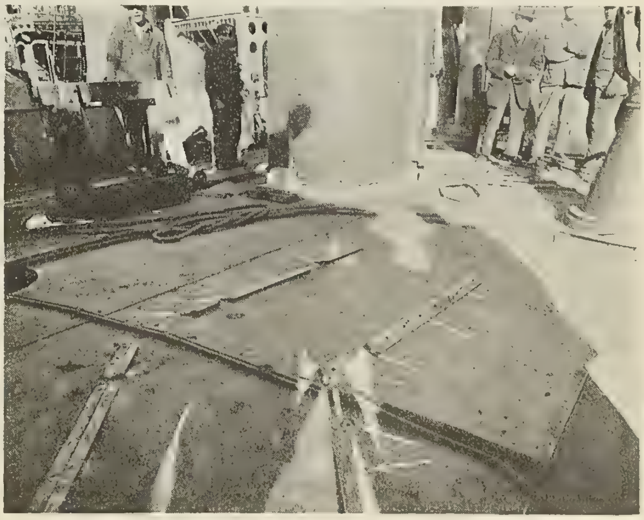


Fig. 4.—Cocoa Matting Holders Welded to Deck

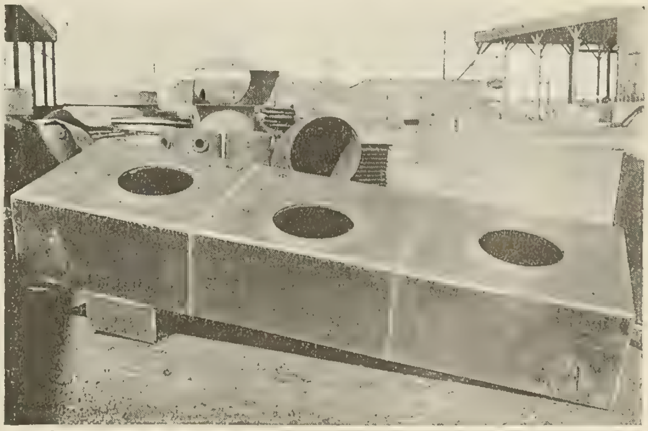
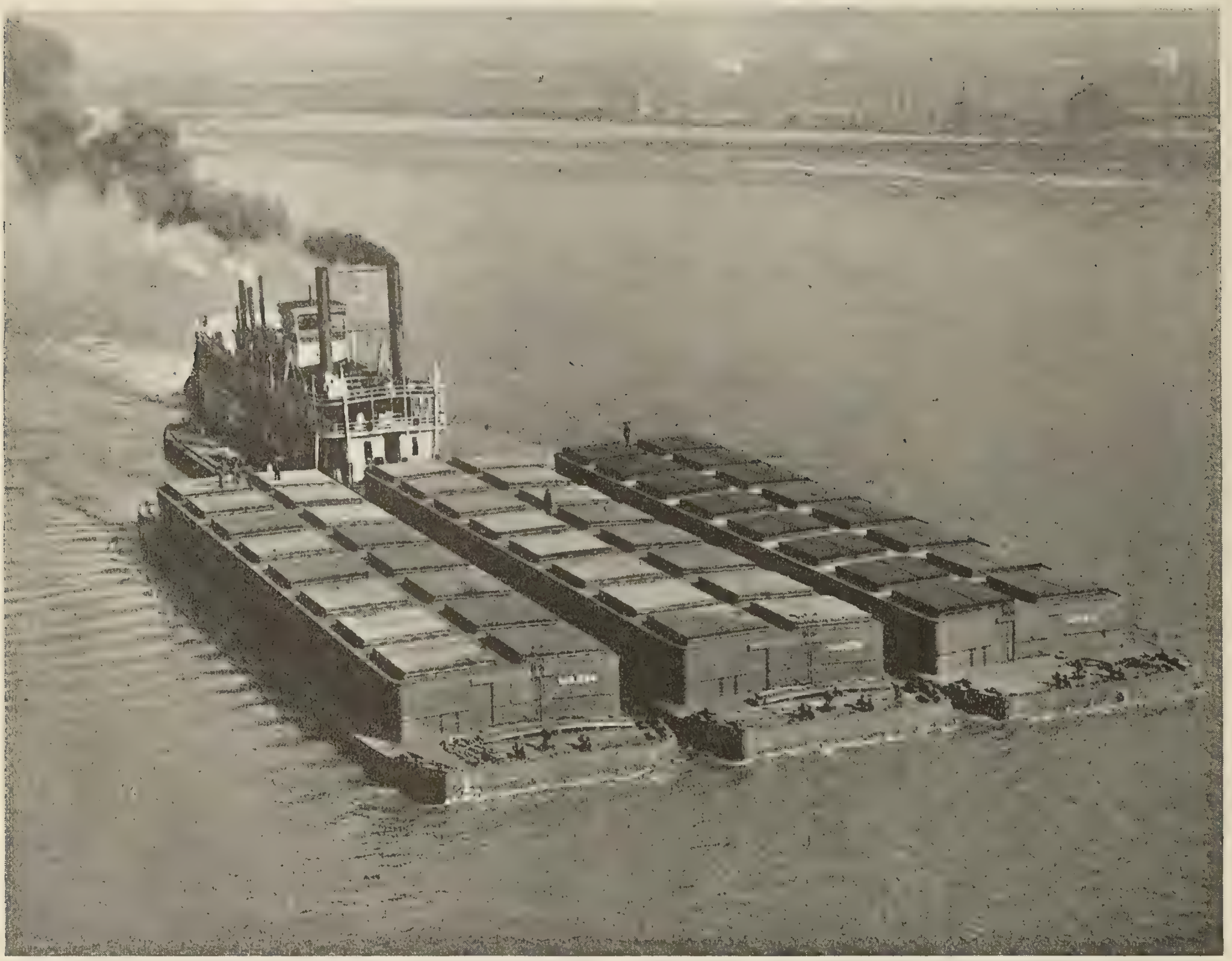


Fig. 5.—Lubricating Oil Tank Completely Welded



Modern Steel Cargo Barges of 2,000 Tons Capacity, Designed by Cox & Stevens, Naval Architects, New York, in Service on the Mississippi River

The accomplishments of the cutting torch are again in evidence throughout the assembly space. Plates are burned to suit irregular castings, frames and shapes are altered to join with bars and clips coming together on the way to the boats. Welders join more bars and fasten pads to bulkheads and weld up inaccessible corners so that the ship will be tight and strong. Here are fastened in place rings with strips welded on to accommodate the proper number of rivets.

Hull Work

On the hull burners cut the major openings, such as the sea chest openings, holes for rudder carriers, shaft tube holes and a great variety of other holes. The electric welding process is used to weld the struts to the shell collars and the propeller guards at the junction of the tubing of the pads. Here also many irregularities in the stern and stem castings are quickly filled in by electric welding.

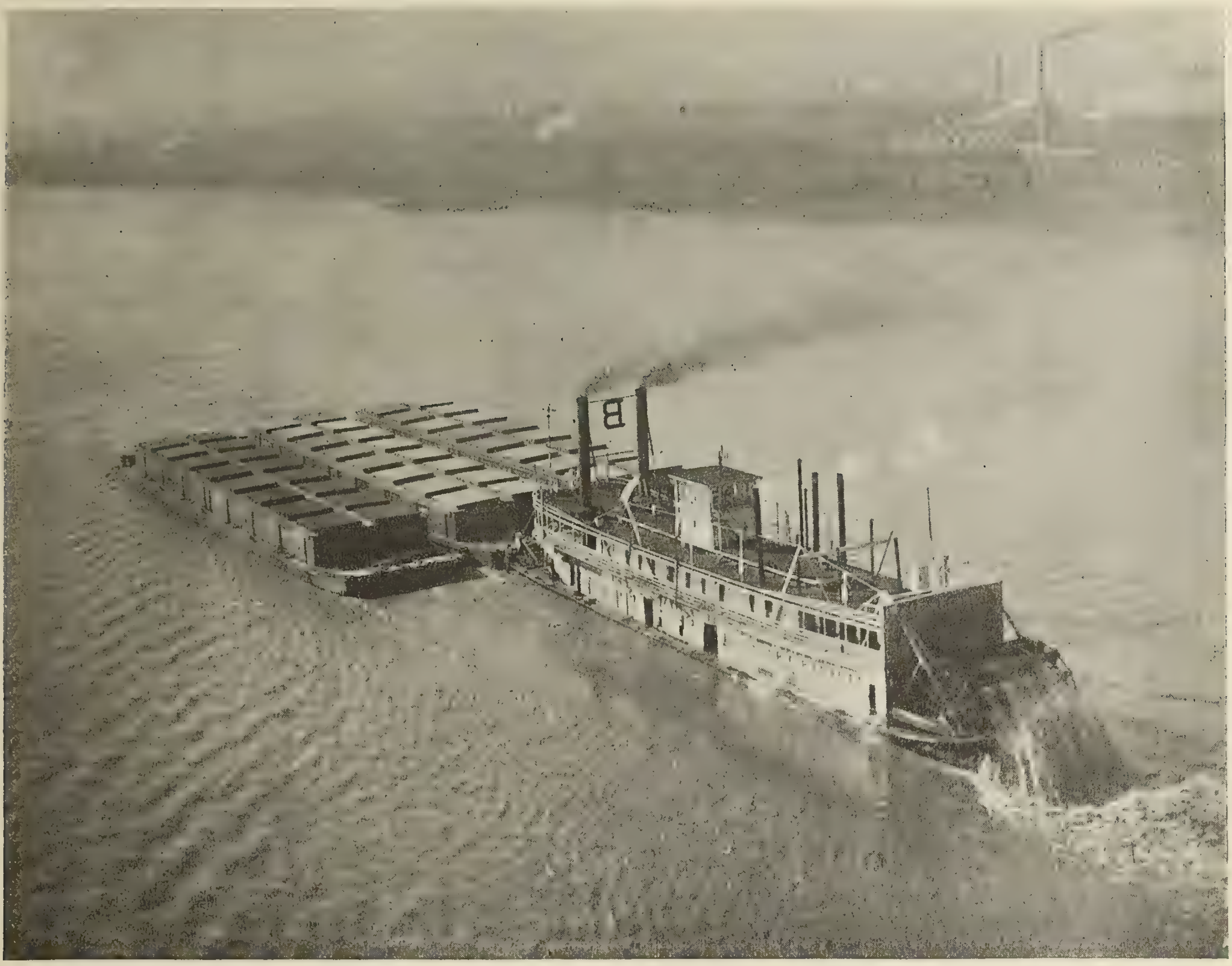
In some cases very large savings are effected by the welders in a few hours on castings in which drilling and other operations open up flaws which have been impossible to observe before hundreds of dollars' worth of labor have been spent on them. The welders repair these flaws without necessitating the removal of the parts from the hull and in many instances without interrupting the normal progress of the work on the piece.

Before the ship is launched the welders and burners serve many departments by cutting holes for pipe systems, ventilation systems, electrical systems, etc. The welder is constantly called upon to fill in holes in bulkheads and decks, in connection with alteration of plans, which relocate foundations and supports after the construction is well under way. In cases of this nature also great savings are made in the cost of construction, as it is not necessary to tear apart whole sections of decks and tank tops to build in new parts, as was necessary before the introduction of electric welding.

Welding at the Fitting-Out Docks

In connection with the work at the fitting-out docks, still other departments are making application of the new process. On the destroyers the cocoa matting strips are all fastened to the deck by welding in place of rivets. A great number of miscellaneous deck fittings, consisting of items such as waterway bars, meat block rings, galley furniture, deck fittings, ventilator coamings, stovepipes, racks, boxes, etc., are electrically welded.

Electrically welded ladders of gratings which are welded to the bulkheads and decks without the use of rivets give access to the lower decks, where a large variety of work is found fastened in place without any screws, bolts or rivets. All of the strips for the metal ceilings are welded in place. Pipehangers or brackets are made a part of the hull itself by means of welding. Pipe stanchions are rigidly welded in place. Air chambers and



Three Abreast the River Barges Are Towed by a Sternwheel Towboat. The Barges Are 230 Feet Long, 45 Feet Beam and 11 Feet Depth

other parts of piping systems, which are tested as high as 600 pounds per square inch, are also electrically welded. Clips, brackets and supporting frames for the instruments for the electrical department are quickly and securely fastened to frames and bulkheads by the same method. Furniture clips, mess table pads, metal lockers and many other parts are welded to the decks.

Welding Supersedes Riveting in Sheet Metal Shop

In the shops welding embraces a wide field of work. Welding has superseded riveting in the sheet metal shop for use in the manufacture of ventilation pipes, fair-weathers, gear covers, port casing, fuel oil inspection tanks, bins, racks, frames, windshields, gravity tanks, drain boxes, and other articles too numerous to mention. In some cases a very large saving in cost has been effected by the application of welding in place of other methods of joining the various parts in process of construction. The spot-welded smokestacks are a noted example of this.

In the machine shops the welders reclaim broken parts of tools, build up worn shafts, reclaim defective castings, repair broken teeth in gears, and many other articles. An illustration of the economy secured by welding is the use of this process in making cutting tools. Small pieces of expensive high-speed steel are welded to inexpensive steel shanks, making efficient and economical tools, which were formerly made entirely of high-speed steel. Many pneumatic and electrical tools are repaired and put back into service by adding a little metal here and there by means of this wonderful "putting on tool," the electric arc.

In the maintenance work the welders at Fore River have to their credit some of the largest jobs of this kind in the country, not excepting the much advertised repairing of the machinery in the damaged German ships. Hydraulic machinery, steam hammers, straightening rolls and many other of the most powerful tools at the pl— have been quickly and successfully repaired by welding.

Example of the Baldbutte

The S. S. *Baldbutte* is a pleasing tribute to the skill of the electric welder, inasmuch as welding played a larger part in the construction of this ship than any previous vessel. The hatches over the engine room, boiler room, galley and mess rooms are completely welded. Railing stanchions, awning stanchions and many other fittings are fastened to the deck by this process; even Old Glory waves from a staff the socket of which is welded to the deck.

Mississippi River Barges in Service

The photographs on this and the preceding page illustrate the manner in which the tows of steel cargo barges designed by Cox & Stevens, naval architects, New York, for the United States Railroad Administration are handled on the Mississippi river. The tow in this case is made up of three barges abreast, propelled by a sternwheel towboat in accordance with the regular western river method of navigation. These barges are 230 feet long and have a cargo carrying capacity of 2,000 tons each.

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A Forty-Knot Destroyer

THAT the highest speed ever attained by a warship should be developed by a destroyer built by Messrs. Yarrow & Company, Ltd., of Scotstoun, Glasgow, is not surprising. For many years this concern has specialized in the construction of high-speed vessels—notably destroyers—and the reputation earned by vessels designed and built at this plant has been an enviable one. Such results have been made possible, however, only by the extensive experimental and research work carried out by this firm, and their latest achievement is a fitting reward for years of painstaking effort. The vessel which has set a new world's record for high speed is the destroyer *Tyrian,* of 1,060 tons displacement, which on December 16 obtained a speed of over 45 miles an hour, or better than 40 knots, on an Admiralty four-hour official trial in deep water. Had the vessel been run in shallow water, a considerably higher speed would undoubtedly have been obtained, so that the performance is all the more remarkable. The *Tyrian* has a length of 273 feet and is fitted with turbine machinery supplied with superheated steam by the latest type of oil-burning Yarrow watertube boilers.

National Marine Week

TO arouse the people of the entire country to take an active interest in the American merchant marine, a series of demonstrations, nation-wide in scope but centering in New York, will be held from April 12 to 17 under the auspices of the National Marine League. Recognizing that the time has come for the nation to realize the pressing economic importance of national maritime independence, the Marine League is leaving no stone unturned to stimulate public interest in marine affairs, and to secure the co-operation of all who have the interest of the American merchant marine at heart.

During "national marine week" interest will center chiefly in the marine exposition which will be held in the Grand Central Palace in New York. This exposition, the first of its kind to be held in this country, will consist of exhibits of maritime relicts, ship models, inventions, shipbuilding methods, etc., including Government exhibits. Although the exposition will be held in New York, the scope of this demonstration will be nation-wide, and an elaborate scheme of publicity will be utilized to focus the attention of the people throughout the country upon maritime problems. The plans for this demonstration so far disclosed are the most ambitious that have yet been proposed for stimulating interest in marine affairs and will have a salutary effect upon the nation, which hitherto has been altogether too indifferent to its welfare as a maritime power.

The Navy's Need of a Merchant Marine

THREE sound reasons why the navy needs a merchant marine are given by the Secretary of the Navy in a recent statement published by the Atlantic Coast Shipbuilders' Association. To naval officers and those who are vitally interested in the development of the United States as a maritime nation, these reasons are in no wise novel—in fact, they have constituted one of the strongest arguments which for years both naval officers and laymen have used in their endeavors to arouse their fellow-countrymen from their indifference to the safeguarding of the prosperity and welfare of the nation. Tardy as the Secretary of the Navy has been in recognizing the force of these arguments and taking active steps to impress upon the people the importance of the merchant marine to the navy, it is nevertheless refreshing to have these facts brought home from such a source even at this late hour.

That the merchant marine is an indispensable arm of the naval service in time of war, which was the Secretary's first reason for the need of an adequate merchant marine, has been amply proved by our experience in the Great War just ended. As pointed out by the Secretary, Germany's attack on the Allies at sea was, with the exception of isolated naval engagements, aimed wholly at the merchant marine of the Allies. The mission of the German Navy was to sink the tonnage of the merchant fleet of the Allies, so that their armies in the field would be unable to operate on account of lack of supplies. Had their attack been successful, the outcome of the war might have been an entirely different story.

The second reason advanced by the Secretary—that the merchant marine is a training school for seamen—is equally important, and the usefulness of a merchant marine for this purpose was again proved by the world war. The disparity between the war strength and peace strength of the naval enlisted personnel is so great that in time of war it is necessary to call into service thousands of inexperienced and untrained men. On the other hand. if the United States maintains an ample merchant marine, seafaring men will, as a result, be available, and the serious predicament in which we were placed at the beginning of the recent war would not be repeated.

As a third reason, the Secretary declares that an added merchant marine will enable the United States to take its proper place among the nations of the world in diplomatic and trade relations. Because the prosperity of our country is directly proportional to the success of our trade

relations with other countries and the magnitude of our foreign trade, it follows that this prosperity will depend upon the ability of our merchants to place their wares in the hands of the foreign consumer without delay and in good condition. The only way in which this can be done is to carry our wares in American vessels owned and operated for the benefit of American industries—not in foreign vessels owned and operated for the benefit of our competitors.

If further argument is needed to show that an adequate merchant marine is a necessity, it is provided in the conclusions of Secretary Daniel's statement when he says that if our possible enemies know that we have an ample and efficient merchant marine they will not be prone to force a possible issue to the extent that war might result. An adequate American trade fleet is in itself a safeguard against declarations of war against the nation.

American Shipbuilding in 1919

BY delivering over 6,000,000 deadweight tons of merchant ships in 1919, American shipbuilders have established a record never before approached by any other country in the world, and a record which is likely to stand as a high water mark for some time to come. In addition to this, a large volume of naval construction, including battleships, cruisers, destroyers, submarines, hospital and ammunition ships, tugs and other auxiliaries, was at the same time under construction.

According to figures supplied just before the close of the year by the Emergency Fleet Corporation, the total number of vessels delivered to the Shipping Board during the year was 1,177, aggregating 6,325,398 deadweight tons. Of this amount, 748 vessels of 4,893,098 deadweight tons were of steel, 425 vessels of 1,418,800 deadweight tons were of wood, and 4 vessels of 13,500 deadweight tons were of concrete. During the year, keels were laid for 660 vessels aggregating 4,542,675 deadweight tons, and 1,087 vessels aggregating 6,058,037 deadweight tons were launched. Of the total net government shipbuilding programme (totaling 2,314 vessels of 13,628,611 deadweight tons), 1,757 vessels of 9,649,319 deadweight tons, or 70.8 percent, have been delivered; 248 vessels of 1,361,814 deadweight tons, or 10 percent, are being outfitted, and 261 vessels of 2,150,703 deadweight tons, or 15.8 percent, are on the ways, leaving 48 vessels of 466,775 deadweight tons, or 3.4 percent, still to be laid down. Considering only the steel ships, which, in the entire programme totaled 1,696 vessels of 11,588,011 deadweight tons, on January 1, 1920, 67 percent had been delivered, 11 percent were being outfitted, and 18 percent were on the ways, leaving 4 percent on which construction had not yet begun.

Although over 70 percent of the government shipbuilding programme is finished, there is no slackening up of work in American shipyards. On the contrary, the industry is steadily forging ahead and work for private accounts is replacing the government work. The shipyards today are building over a quarter of a million gross tons more than they were a month ago and nearly half a million tons more than in October. The total now under construction, exclusive of all government work, amounts to more than 1,200,000 deadweight tons of sea-going merchant vessels. In all this work for private account only one vessel is under construction for foreign owners, so that at present practically 100 percent of the work being done in American shipyards is for American owners.

This steady advance, according to a statement issued by the Atlantic Coast Shipbuilders' Association, is only one of the encouraging features of the development of the American shipbuilding industry. The shipbuilders themselves continue to show faith in the future of the American merchant marine by taking over contracts given up by the Shipping Board, and will complete the partially constructed vessels in the expectation of finding a market for them. Conditions indicate that they are justified in the belief that there will be a continued demand for American tonnage. The Shipbuilders' Association also points out that as matters stand today the United States is the only nation in the world in a position to supply merchant vessels quickly and in quantity, the British shipyards being tied up with orders for two years to come while other foreign countries are unable to supply the home demand and are seeking tonnage elsewhere.

The World's Oil Supply

AT the present rates of production and consumption the future oil supply of the United States is a matter of grave concern, according to statements by George Otis Smith, director of the United States Geological Survey. Last year the production of our oil wells was more than one-twentieth of the amount estimated by the Survey geologists as the contents of our underground reserves. We also drew from storage nearly one-fifth of what remains above ground.

Although it is true that the United States today is the largest oil producer in the world, yet it is also true that this country consumes nearly 75 percent of the world's output of oil, and the demand is steadily increasing. How this condition is likely to affect the shipping industry may be judged from the fact that the new demands of our ship programme alone involve fuel oil in quantities equivalent to nearly one-half of the domestic output, and unless there is some corresponding decrease in other demands, this new requirement must be met with an increase in production of nearly 200,000,000 barrels.

Two methods of handling the problem of a future oil supply are suggested by Mr. Smith: either reserve the domestic oil fields for American development and thus prevent foreign acquisition of what is needed at home, or encourage American capital to enter foreign fields to assist in their development, thus insuring an additional supply of oil for our needs. The first method obviously would be only a temporary solution of the problem and is hardly in keeping with the policy of other large oil-using countries. Whatever is done, the situation should be a forceful reminder to marine engineers of the necessity for improving the economy of power-generating machinery of every type which is dependent upon the use of oil as fuel.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

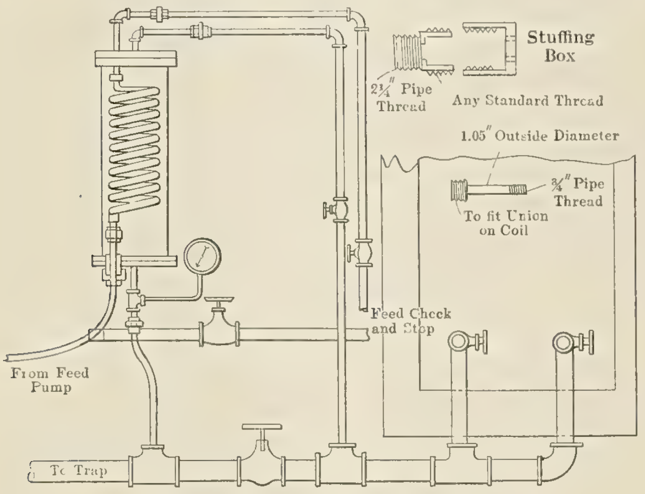
This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Increasing Evaporator Efficiency

Recently we have made an evaporator feed heater aboard our vessel, and I think that it has proved its worth and value, and other readers of MARINE ENGINEERING may find it profitable to construct one for themselves.

We have two units of Curtiss turbines of about 6,000 horsepower, also two DeLaval engines for the circulating pumps. The loss of feed water by steam leak from these is considerable. We have a Reilly evaporator with which we evaporated river water to make up the loss of feed water, but it was not possible to maintain the feed even by using the evaporator constantly.

The parts needed for the feed heater are easily turned out on a lathe. Use a piece of 7-inch pipe about 36 inches



Arrangement of Evaporator Feed Heater

long, with two blank flanges. Drill and tap two ¾-inch pipe taps in one of the flanges. In the other flange drill and tap for ¾-inch and 2¼-inch pipe. Place one of the evaporator coils in the pipe and lay off the position of the 2¼-inch hole. Turn out two fittings for the unions on the coils, making the male with a nipple about 6 inches long. One of the unions can then be screwed into the flange ends. One nipple has to be threaded about 3 inches, and may be screwed into the flange. A simple stuffing box may be made for the other nipple to pass through. Place the coil in the pipe, one nipple through the stuffing box and then bolt up the flanges.

The whole apparatus can be secured to the bulkhead near the evaporator by iron straps. Put a valve on the evaporator drain and a "T" on either side. Run pipe from the nearest evaporator to the upper end of heater, and place the valve in this line. From the bottom of the heater run a line of pipe to the "T" on the farther side of the valve. It is advisable to place a low-pressure steam gage on this line. Now place a stop valve on the feed line to the evaporator, and pipe from either side of this valve to the heater; run water from the pump to the bottom end of the heater and from the top of the heater to the evaporator.

By using the valve on the drain line and having the drain valves opened wide the pressure can be regulated in the heater to about 5 pounds, obtaining sufficient pressure to dump the trap and still getting the greatest amount of heat from the steam. The heater will raise the temperature of the feed water to about 180 degrees Fahrenheit and the evaporator will do 100 percent more work on less steam pressure. Care must be taken not to raise the temperature too high in the heater, because the heater will become salted and dirty and need cleaning.

Cleaning may be accomplished very easily by opening by passes on the drain and feed lines, securing other valves to and from the heater. Remove the bottom flange and lift the top flange out, the coil coming with it.

Anyone troubled by not being able to make up sufficient feed water with an evaporator I recommend their trying this feed heater, and they will be surprised and pleased by the fine results. Also it has a saving in itself, for reserve feed tanks can be filled with river water on either side of the Atlantic; and the evaporator can be used, as the water obtained in some ports is not only expensive, but very hard and poor feed for watertube boilers.

Philadelphia, Pa. F. T. HOBLEY.

Value of the Ejector

Several steamers have foundered in the Atlantic during the last few months, although there has been no very severe weather so far this season. These ships went down from the inability of the pumps to keep them free of water, and from no cause of the pumps themselves, but from the fact that the bilge suction strainers were so covered with refuse that the water could not get through to the suction pipes.

Whenever this happens the normal water service used for cooling the working parts of engines, together with the usual leaks in the engine room, quickly raise the water in the bilge to such a height that a man has to dive down to the strainer box to clean it.

In a heavy seaway this is a dangerous thing to do, for in many ships the bilge suctions are placed in a section between two tanks with only a manhole through which to reach the strainer. If the man is swept away he is like one who has fallen through a hole in the ice—"up against it."

In such an emergency there is one thing, however, that an engineer will turn to if he has it on the ship, and that is the ejector, or siphon, as it is called.

This instrument blows the water out in a continuous stream as long as steam and water are supplied. The suction pipe to the ejector, by the use of a couple of elbows, can be made to lift up, so the strainer on the end can be cleaned. A smooth-bore suction hose which can be dropped down in any part of the bilge is very handy. This hose may be kept up out of the way of oil when not in use. There should be one of these siphons on each side of the engine room.

The objection to installing an ejector is that a ship has pumps and that pumps are more economical in the use of steam than a siphon. Even so, if one of these little machines is able to save one ship out of a hundred the cost should not be thought of.

The steam valve can be locked and the key kept in the chief engineer's room, so that the machine need only be used in case of necessity, when the ship's pumps—be there ever so many aboard—cannot get the water that is rising in the ship.

New York, N. Y. F. C. Getliffe,
Marine Engineer.

Some CO_2 Compressor Valve and Gland Packing Defects, with Their Remedies

During the homeward-bound voyage of the vessel on which the writer was assistant refrigeration engineer, the following incident occurred when the ship was well on towards the line of the equator, with a full cargo in all the refrigerated holds.

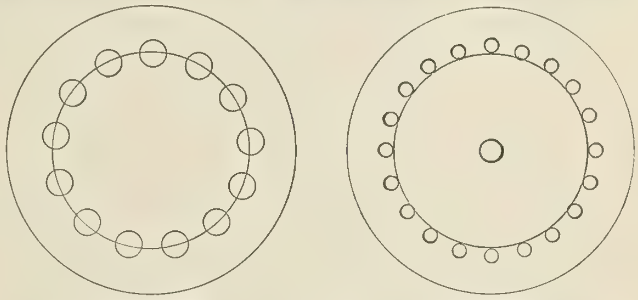
The refrigeration plant was composed of two duplicate sets of CO_2 machines, formed into separate units, each compressor being driven by a compound steam condensing engine, with cylinders placed in tandem. The tail rod of the steam set was connected to the gas compressor rod by a suitable coupling. The compressors were secured to the vertical framing at the end of the sole plate, and were overhung, inasmuch as there was no other support. The gas suction and delivery valves were made of flat disks of steel, and when the compressors were opened out for the renewal of bucket and gland leathers the opportunity was always taken to withdraw these valves for examination. If they showed the slightest sign of any defect, such as a cracked opening however minute, they were rejected and spare valves, of which we carried a fair supply, were substituted. The valve casing or cage was cunningly constructed so that in the event of a valve breaking into two or three pieces these pieces would be prevented from being drawn into the compressor.

Shortly after taking over my watch I started up one of the machines. They were each rated at 75 tons refrigeration per 24 hours, and one set was capable of maintaining the cargo at the required temperature, though the chief refrigerating engineer usually operated one machine on his watch and I ran the other, thus insuring both sets being in first-class order in case of an emergency. It soon became evident that one of the compressor gas suction valves was inclined to jam momentarily away from its seat so that on the return stroke of the compressor bucket the gas at the evaporator pressure (150 pounds) was forced back into the suction pipe instead of being compressed. This caused the machine to suddenly accelerate its speed for a few revolutions, the defective valve always closing before the end of the stroke. At every stroke the valve was sent to its seat with lightning-like rapidity.

I did not consider at the time that it would be wise to close down the machine, hoping to complete the necessary run of a few hours, when in the ordinary course of events the compressor would be opened up and a new valve fitted. The inevitable happened, however, and the valve fractured, allowing the machine, with its heavy flywheel, to race badly for a few seconds before I was able to shut off steam. On opening up the suction valves we found one of them broken in two, and as the trouble with suction valves had become somewhat frequent of late, the chief engineer decided that some change in design was urgent. After a time, during which several ideas were submitted, the altered design shown in Fig. 1 was arrived at. As we had a lathe on board and plenty of white metal, castings were made of the desired shape and machined and finished to size so that the new fittings could be quickly procured when we arrived at our destination. The new valves proved to be superior to the old design and displaced them during the remainder of the time I was on that vessel.

Hydraulic Leathers Used to Make Compressor Glands Gas-Tight

While writing of CO_2 machines I may mention that the compressor rod glands were made gas-tight by the use of hydraulic leathers held to their shape by rubber rings. These rings usually were used only once, that is, they were discarded when new leathers were fitted. This became rather costly, and I tried wrapping the rings tightly with electrician's jointing tape and found that this



OLD DESIGN — Defects. Insufficient Initial Area for Gas in Compressor to Effect Closing of Valve and Suction Gas Throttled

NEW DESIGN — Total Valve Area Utilized to Close Valve and Flow of Gas Not Impeded

Fig. 1

enabled us to lengthen the life of the rubbers so that they could then be used again.

We often had a run of bad luck with the compressor gland leathers giving out entirely when we were hard pressed in tropical seas, with the high temperature condensing water at, say, 86 degrees to 90 degrees F. when lying in such ports as Colombo or Bombay. Once the gland leathers carried away suddenly, and the resulting smoke screen, if one may so term it, of vaporized sealing oil and heavy carbonic acid vapors made it rather difficult to reach the engine stop valve to shut off steam. The leathers were pressed in the mold, and while so fixed were placed under the high-pressure cylinder to receive a certain amount of heat treatment. After trimming the rough edges of the cup leathers they were removed from the mold, and just prior to being fitted to the compressors were immersed in kerosene for about 10 minutes or less. The result of this latter treatment was simply astonishing. One set of gland leathers so treated gave perfect service during the whole of one voyage which lasted for nearly four months. The machine was run under all the varying conditions incidental to everyday practical refrigeration, viz., the compressor frosting up and, again, the compressor rod running warm; also under the trying conditions of tropical seas, when the condensing pressure amounted to 1,100 pounds per square inch.

On another occasion, when the ship's refrigerating plant consisted of a small duplex machine of about 15 tons capacity, used only for maintaining the ship's stores, and a small cargo chamber at freezing temperatures, we experienced a great deal of trouble with unsuitable gland leathers while away on commission. As our stock of spare leathers became seriously reduced we were soon faced with the imminence of a compulsory stoppage of all re-

frigerating apparatus, with the consequent loss of our refrigerated stores and cargo. We eventually overcame the difficulty by designing, making and fitting a new style of packing (Fig. 2), which enabled us to carry on until we reached port and replenished our exhausted gland leather supply. The white metal used was rather soft and of the "lead base" variety, and, as this ship's equipment included an invaluable lathe, we soon had the new rings turned out and carefully fitted (a good sliding fit to the spare compressor rods and also to the bore of the gland orifice). Special pains were taken to taper the white metal rings to a knife edge, and they were carefully inserted along the rod to insure that the fine edges of the sensitive white

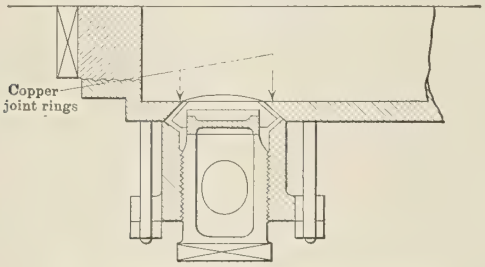


Fig. 2.—Half Section CO_2 Compressor

metal should remain unblemished and make as good a joint as possible at the commencement. This packing ran well, but great attention was given to the machine to keep the rods at as even a temperature as possible.

I have had experience with the new white metal packings now supplied to this make of CO_2 machine and can only say that, in my experience, this departure is the last word in gland packings, as, given proper care and intelligent handling at the start, they soon build themselves up to their duties and then run gas-tight under practically all usual conditions and give no trouble.

Port Chalmers, N. Z. W. I. ESPLIN.

Why the St. Saboda Was Late

Is there an engineer anywhere who doesn't hark back occasionally to the good old days of apprenticeship—to the days of bitter-sweet remembrances—and instantly recollect some incident, accident or repair, amusing or otherwise, that warms his heart, quickens his blood or blurs his eye?—and finally pop goes his safety valve and he spills the whole story.

Claiming no exception to the rule, though I am now in the stationary game by choice, Neptune once knew me and bore compassion. 'Tis a long hail from here to the salt Pacific, but not so far that I can't smell the "beeswax" cylinder lubricant frizzling on the cylinder heads and my mind is wafted off to green fields and clover with the glorious, fragrant perfume of it.

Beeswax as a lubricant is rather antiquated, no doubt, and perhaps has passed into history now, but the fact remains, although it was never used in very large quantities, as may well be imagined, it has its advantages.

However, in marine work the vertical inverted engine requires little, if any, lubrication, and that confined to "swabbing the rods," as the saying goes, in the old days with a combination of wax and low-quality steam as the necessary ingredients.

But a time of trouble came to us on one voyage, as it has a habit of doing at sea, although it was not particularly traceable to the inefficiency of the lubricant. It all began with a heartrending thump in the intermediate cylinder, which, being repeated at odd intervals, aroused the "gang" to action. The ship's engines were closed down to quarter speed and a hurried external examination made, which revealed absolutely nothing.

As everything seemed intact and serviceable and no further indications of pending disaster occurred, speed was again cautiously resumed. No sooner had the wheel turned over a few times than the thumping was repeated, this time far worse and more frequently than before.

The chief engineer was entirely cool, though Scotch. It was evident, however, that the difficulty was a new one to him. He gave orders to stop ship when he found there was sufficient sea room, and to put in the jacking gear to keep the engine from moving in the sea-way, also to take off the head of the cylinder giving trouble. All this was done for inspection.

To our entire surprise, nothing unusual came to view on the careful examination then given the cylinder. There was nothing broken, nor did any loose follower bolts show.

Everything looked ship shape and without a mark to indicate what the trouble could be to cause such a commotion.

One revolution of the engine by means of the jacking gear permitted the inspection of the cylinder bore, and the checking of the striking points revealed nothing. Handhole inspection at the bottom end had a like result.

The chief lit a cigar while the ship rolled in the trough of an oily sea and a few white faces of voyagers anxiously peered down from the skylights overhead.

Almost stumped, he sat there on the elevated platform, his feet dangling in midair, silent and thoughtful. The second cigar, too, was lighted, while the crew sat in silence, apparently not to distract the deep thought of the chief.

But no—one old "chaw" broke the quiet when an unusually heavy sea threw him off his soap-box, and was heard to remark something about a "blarsted old walloper, wud roll th' feathers off a goose."

"Pike! Just measure the distance that head sets into the piston." "Eight inches, you say?" "And it's seven and three-quarters drop into the counterbore before you strike the liner!" "Well, it's a cinch the liner is working."

By the aid of two small jacks, some blocking, strong backs and so on, we forced the loose cylinder liner down into its place four inches below the bottom of the head when in its normal position.

Meanwhile the cylinder head had been turned over and lashed, the engine-room machine shop (the old man's strong back and a ratchet drill) assembled and four holes drilled into the bottom of the head and tapped for one-inch stud bolts, which were screwed into place and left projecting 4 inches. When the head was replaced the four studs met the narrow edge of the cylinder liner thus preventing its up-and-down travel and eliminating the cause of the disturbance. The jacking engine was started and a turn taken out of the engine. As all seemed clear, the gear was taken out and the main throttle opened to give the engine a few turns either way to test the propeller.

"All clear," the telegraph bell rattled like a ruptured dishpan. "Full ahead!" came the reply. The quick rush of steam, her pulse steady, the old *Saboda* took the bone in her teeth and headed north.

The chief engineer walked out into the stokehold with a twinkle in his eye. "All right, boys, shake her up. We're only three hours late; we can make Seattle before they close up—and you, Kelly, can "get into" that after starboard bunker while ye are resting yourself. Ye'll find good Nanaimo coal in thar."

Holyoke, Mass." HARRY A. LIVINGSTON.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Machinery Weights

Q. (1028).—Please publish an approximate formula for estimating the weight (wet) for the following types of machinery installations based on indicated horsepower or shaft horsepower: Scotch boilers with turbines and reduction gear, watertube boilers with turbines and reduction gear, and watertube boilers with reciprocating engines.

A. (1028).—Your question, if taken to include naval together with merchant (passenger and cargo) practice, would cover such a wide field that it seems best to limit it to only the ordinary freight steamship. You also should realize that using merely the shaft horsepower or indicated horsepower as a basis does not allow for the variation in revolutions per minute with different reciprocating engines (merchant types may vary from 65 to 95) for the fact that the heating surface of the boilers chosen in some particular case may be different from that upon which our formula is based.

Approximate Machinery Weights

1. Reciprocating engines and Scotch boilers, .220 ton per indicated horsepower.
2. Geared turbines and Scotch boilers, .225 ton per shaft horsepower.
3. Reciprocating engines and watertube boilers, .185 ton per indicated horsepower.
4. Geared turbines and watertube boilers, .190 ton per shaft horsepower.

In using the above ratios it must be realized that they obtain for about 1,000 to 4,000 horsepower installations. It appears to be customary in watertube installations to provide a greater amount of heating surface in proportion to the horsepower than for Scotch boilers, possibly in part due to the fact that watertube boilers come in standard sizes, while Scotch boilers are usually made up by the shipyard, and also due to the heating surface of the Scotch boiler being more readily cleaned while the boiler is in operation.

Machinery weight is here considered to include all engines, pumps and piping in the engine and boiler rooms, together with stack, uptakes, floor plates, propeller, shafting and bearings. The weights for the turbine installations are based on the use of condenser equipment of the same type employed with reciprocating engines.

In obtaining the weight of existing installations, it would seem better practice to use a formula containing more variables. A paper by Professor McDermott (Transactions of the Society of Naval Architects and Marine Engineers, 1897, page 180) gives some interesting formulae, a few of which are here quoted:

Engine Room Weights

Engine room weights include main engines (except shafting, bed plates, shaft bearings, cap bolts, etc.), auxiliary engines, all pump connections, condensers, water in condensers and pipes, pipes in engine room, tools, workshop fittings, platform gratings, ladders, ventilation fans to engine room.

D = sum of squares of diameters (inches) of each cylinder.

L = stroke (feet).

N = number of engines.

Weight in tons = $.018\, n\, [(DL)^{7/8} + 390]$.

Shafting

(Crank, line, thrust, propeller shafts, engine bed plates, caps, bolts, etc.)

D^2L = sum of [diameter (inches)^2 $\times$ length (feet)] of crank, thrust, line and propeller shafts.

Weight in tons = $.0026 D^2L$.

Note.—Caution should be used in applying this formula to vessels having engines aft.

Boiler Room Weights

(Boiler mountings, uptakes, smoke stacks, pipes in boiler room, forced or assisted draft arrangements and appliances, ventilating arrangement, ash hoist, stokehold plates, platform gratings, ladders, fire bars, tools and water.)

Scotch Boilers.—Water 8 inches above top row of tubes.

L = mean diameter (feet).

HS = heating surface, one boiler.

N = number of boilers.

Boiler Room Equipment.—Scotch, single-end.

Weight in tons = $.0085\, N\, [D^2\, (L + 2) + HS] + 10\, N$.

Propellers

(Boss, blades and bolts.)

D = diameter in feet.

S = surface in square feet.

N = number of propellers.

Three-bladed, detachable-blade, steel or bronze propellers.

When $D\sqrt{S} < 50$

Weight in tons = $.03\, ND\sqrt{S}$.

When $D\sqrt{S} > 50$

Weight in tons = $.11\, N\, (D\sqrt{S} - 36.3)$.

Four-bladed, detachable-blade, steel or bronze propellers.

When $D\sqrt{S} < 50$

Weight in tons = $.028\, ND\sqrt{S}$.

When $D\sqrt{S} > 50$

Weight in tons = $.10\, N\, (D\sqrt{S} - 40)$.

For cast iron solid propellers add 20 percent to the above.

For steel or bronze solid propellers deduct 25 percent from the above.

For cast iron propellers deduct 10 percent from the above.

It has been estimated that internal combustion engines now furnish approximately two-thirds of all the prime motive power generated in the world. Those burning gasoline (petrol) furnish about 95 percent of this motive power.—*R. B. Blakely before the American Society of Mechanical Engineers.*

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

BIG DEMAND FOR TANKERS KEEPING AMERICAN SHIP BUILDERS MORE BUSY

Each Month Shows a Gain in Orders—Lead of Freighters Reduced—Speed of Production Great Factor in Obtaining Contracts—Work Gets Top Rating.

"American shipyards, instead of falling back as Government contracts are suspended, cancelled or completed, are forging steadily ahead," says a statement just issued by the Atlantic Coast Shipbuilders' Association. "Work for private accounts is replacing that which was being done for the Shipping Board, and although a number of orders for American industries have been completed or withdrawn during the past few weeks, the shipyards to-day are building over a quarter of a million gross tons more than they were a month ago, and nearly half a million tons more than in October. The total now under construction, exclusive of all Government work, is 805,000 gross tons, the equivalent of more than 1,200,000 deadweight tons of sea-going vessels.

"This steady advance is only one of the encouraging features in the development of the American shipbuilding industry. The shipbuilders themselves continue to show faith in the future of the American merchant marine by taking over contracts given up by the Shipping Board, and will complete the partially constructed vessels in the expectation of finding a market for them. Conditions indicate that they are justified in the belief that there will be a continued demand for American tonnage.

"As matters stand to-day, the United States is the only nation in the world in a position to supply merchant vessels quickly and in quantity. The British shipyards are tied up with orders for two years to come. Other foreign countries are unable to supply the home demand and are seeking tonnage elsewhere. There is nowhere to place orders for prompt delivery but in the United States, and only the unfavorable position of the exchange and the insistence upon long term credits are keeping back a flood of foregin orders. While American tonnage prices are still only about ten per cent above the British on a basis of currency parity, the high value of the dollar in comparison to the monetary units of other countries, due to the abnormal exchange situation, temporarily imposes upon the buyer of American products a handicap of twenty per cent. As soon as the exchange begins to right itself, however, European shipowners are expected to place contracts in this country.

"The factor of speedy delivery," the statement continues, "is a powerful asset for American shipyards. Leading British shipbuilders who have visited the principal plants in the United States frankly admit that the output here is at the rate of two to three times that of the British yards. This means that, shipway for shipway, this country can produce double to treble the tonnage that Great Britain can. Furthermore, with the great rapidity of turnover, the American shipbuilding industry is getting so much more service out of its plants that this factor will result in a marked lessening of production costs that will enable the United States to meet England's prices, which are at present lower because of cheaper labor.

"That speed of production, due largely to the employment of more modern methods and the greater use of labor-saving devices than in Britain, has not lessened the quality of American-built ships, is plainly manifest. Since the armistice, Lloyd's Register of Shipping, a British institution, has supervised the complete construction of nearly six hundred steel steamers in United States yards, and has rated every one of them 100-A1, the highest class given.

"The showing of the American yards is the more remarkable in that of 152 ships now being constructed for private account only one is to foreign order. At present, therefore, American industry is providing practically 100 percent of the work being done, in spite of the fact that the Shipping Board is trying to dispose of hundreds of completed ships on liberal credit terms.

"The total of 805,000 gross tons under construction does not represent all the work American shipbuilders have in hand, for additional contracts which have been placed, but upon which operations have not been begun, will bring the total to more than 1,000,000 tons.

"Details of the work actually under way have been prepared from official classification records of the American Bureau of Shipping and Lloyd's Register. An analysis of these figures shows that the volume of orders has been increasing steadily, both November and December marking increases of about 50 percent over the previous month, the totals under construction for the three months being: October, 347,343 gross tons; November, 550,714 gross tons; December, 805,147 gross tons.

"The rapidly increasing demand for tanker tonnage, due to the recent marked development of the oil-burning ships here and abroad, is reflected in the returns. Whereas, in October, 160,000 gross tons more of freighters were being built than of tankers, at present the excess of cargo-carrying tonnage under construction is only about 30,000, as the following table covering the various types of tonnage for the past three months show —(totals in gross tons):

	Oct.	Nov.	Dec.
Freighters	235,523	295,493	400,556
Tankers	74,437	214,940	369,084
Other types ...	37,383	40,281	35,507
Total	347,343	550,714	805,147

To Recognize American Bureau of Shipping

Just before the adjournment of Congress the House Committee on Merchant Marine and Fisheries reported to the House of Representatives unanimously the bill, introduced by Representative G. W. Edmonds, of Pennsylvania, recognizing the American Bureau of Shipping as the official classification society of the United States. The bill differed from the one originally reported in two respects. An amendment directing recognition "so long as the American Bureau of Shipping continues to be maintained as an organization, which has no capital stock and pays no dividends," was made. A further provision that "the official list of merchant vessels published by the Government shall hereafter contain a notation clearly indicating all vessels classed by the American Bureau of Shipping," was added.

Will Build Steel Hereafter

A new steam trawler, the *Medric,* is about ready for launching at the yard of the Portland Shipbuilding Co., at South Portland, Me. She is the seventh boat of that class built at this yard for the East Coast Fisheries Co., and will be the last one to be built there, as only steel craft will be contracted for by the fish concern in the future.

Capt. E. R. Norton, superintendent of the local company, expects to find plenty of work in the other direction.

SHIPPING BOARD TO PUSH SALE OF 1,400,000 TONS OF WOODEN VESSELS

Many Will Be Offered to Foreign Buyers—Minimum Value of Fleet, $126,000,000—Anderson Contract Agreed On—Some Small Steel Vessels May Also Be Sold

Word comes from Washington that an intensive campaign to dispose of 400 wooden vessels here and abroad will shortly be begun by the United States Shipping Board. The Anderson Overseas Corporation will undertake to dispose of as many of these ships as possible to foreign interests.

A contract which will give a percentage profit to the corporation as sales agent is now being drawn up by the legal department of the Shipping Board. The terms of the contract have already been decided on, and as soon as the legal technicalities are worked out the contract will be signed and will go into effect.

The wooden ships average 3,500 deadweight tons each, and the total is $1,400,000 tons. The prices which have been asked for the ships by the Board have varied from $90 to $115 a ton, depending upon the terms of payment. The value of the wooden fleet on this basis is from $126,000,000 to $161,000,000, and the value of each vessel is from $315,000 to $402,500.

Under the standard terms asked by the Shipping Board, the wooden ships are sold for $90 a deadweight ton cash; $100 per ton with 50 cer cent cash and the remainder in eighteen months, and $115 per ton with 25 per cent cash and the balance in three years. The exact terms upon which the vessels will be offered to foreign interests have not been announced, but it is said that they will certainly not be more favorable than those offered to American buyers.

It has been known for some time that the Shipping Board is anxious to dispose of its wooden fleet. Sales have gone slowly in the United States because of the preference of Americans for steel vessels. The Board feels that to establish the American merchant marine on a permanent basis it is necessary to retain its better ships either under Government control or under the ownership of private concerns under the American flag.

The wooden vessels were constructed to meet the war emergency, and since the signing of the armistice have been a burden upon the Board. In its efforts to obtain a well balanced fleet the Board has announced its policy of selling not only the wooden vessels either to American or foreign concerns, but also any of the smaller steel ships up to 4,000 tons.

It is held that the medium-sized and larger vessels can be operated at a greater profit because of the lower percentage of overhead charge per ton of freight carried. There is a belief among members of the Board, however, that, while there is a surplus of tonnage available for sale here, there is a shortage abroad.

CLYDE BUYS RAPOREL

Transfer of Steamship Interests Involves About 100.000 Tons

Announcement was made at the offices of the Clyde Steamship Company a few days ago that the company had acquired the steamship interests of Edward M. Raphel & Company and the Raporel Steamship Line. The Raporel Line will continue operation as heretofore, with its offices at 17 Battery Place. C. H. C. Pearsall, of the Raporel Line, expects to open a regular freight service from Philadelphia to Avonmouth and Hull within a few weeks, having already established an office in the Bourse building, Philadelphia.

In addition to maintaining a regular freight service between New York and Haiti, Windward and Leeward Islands and Virgin Islands, the Raporel Steamship Line operates eight Shipping Board vessels to the West Indies. These are the *Lake Ogden, Lake Sunapee, Lake View, Lake Narka, Ledan, Shawano, Atlantus* and *Connersville*. For owners' account Raporel is operating the steamers *Fordonian, St. Charles, City of Puebla, Deerfield* and *West Catanace*. The last two are refrigerators purchased from the Shipping Board by the Eldorado Steamship Company, of 50 Broad street. The *Deerfield* is running between South American and Northern European ports, and the *West Catanace* is in the Black Sea trade. Two chartered steamers are being operated by the line, the *Georgeanna Weems* and the *Dorothy*. The total amount of tonnage Raporel at present has under operation, including the Shipping Board vessels, is about 100,000.

STANDARD TO BUILD TWO

Cuyamel Fruit Company Adds to Its Combination Fleet

Two special type combination fruit and passenger ships are to be built by the Standard Shipbuilding Corporation for the Cuyamel Fruit Company of New Orleans, the contracts having just been awarded. Delivery has been guaranteed for the last of next May and June, and construction will be begun immediately. The steamers will be 235 feet long, 34 feet beam and 16 feet deep, with a speed of 11 knots and accommodations for 30 passengers. It is considered probable that they will cost more than $500,000 each.

The Cuyamel Fruit Company has two similar ships now being built at the Newburgh Shipyards, which will be ready shortly before the vessels just contracted for.

Another shipbuilding plant in New York is expected to land a large contract for private construction in a short time. It is understood to be dependent upon the flotation of a loan for $3,000,000, details for which are said to have been arranged. The yard is said to be in the position of being able to get the contracts if the loan is arranged, and the loan if the contracts are landed.

SHIP CASES DISPOSED OF

Payments of $18,300,360 Approved, Concerning 314 Cases

A record of claims disposed of by the Cancellation, Claims and Contracts Board of the United States Shipping Board Emergency Fleet Corporation, just made public, shows that since the signing of the armistice 314 cases have been approved for payment involving a total loss of $18,300,360. In 52 other cases advances have been recommended, bringing the total up to 366 cases involving $22,197,934.

The documents made public contain 201 cases which have been acted upon since Judge Payne became Chairman of the Board in August. Of these 164 cases were approved for payment, while advances were recommended in 37 others, the cases approved for payment totaling $14,856,620, and advances recommended totaling $2,357,759, a grand total of $17,214,379.

There were few claims settled where the amount allowed exceeded $1,000,000. The largest was granted to the McEachern Ship Company, of Astoria, Ore. The company claimed $6,259,414.92 for the cancellation of contracts 96 and 330, calling for wooden hulls. It was allowed $5,415,212.92.

BUYS NEW YORK HOME

Shipping Board Gets Hamburg-American Building

The United States Shipping Board has bought the Hamburg-American building, No. 45 Broadway, New York, for $2,000,000, from the Atlas Steamship Line, the stock of which is held by the Alien Property Custodian.

Three floors of the structure, which is an 11-story building, will be occupied by the army for about six months, after which they will be taken over by the Board. Departments of the Shipping Board which will have offices in the building are those of operations, treasurer, repair and part of the accounting force.

More Contracts for Downey

The Downey Shipbuilding Corporation closed contracts a few days ago with the Southern Pacific Company to build three 12-knot steel steamships, length over all 352 feet, molded beam 47 feet, molded depth to hurricane deck 32 feet 6 inches, mean loaded draft 23 feet. Propelling machinery will be triple expansion reciprocating steam engines, Scotch boilers, oil burning. The auxiliary and general equipment of these three steamships will be of the highest class, in accordance with the practice of the company.

69 NEW STEAMERS FOR NIPPON YUSEN KAISHA

Japan's Premier Company Will Add 515,000 Tons to Its Fleet—High Speed Passenger Boats Part of Programme—Will Compete for Trans-Pacific Trade.

Recently announced developments show that Japanese shipping interests are entering seriously on the task of obtaining a large share of the world's carrying trade. The after-war programme of the Nippon Yusen Kaisha shows that the big Japanese steamship company plans to add 515,000 tons of new shipping to its already large fleet, which will increase the total to more than 1,000,000 tons. Of the 69 ships to be built 36, aggregating 382,000 tons, will be used in foreign trade and the remainder for coasting and China business.

The estimated cost, $110,000,000, will be obtained from the company's reserve fund and the sale of some of its obsolete vessels, and the programme will carry shipbuilding work forward into 1925.

One feature of the projected addition to the fleet is a group of high-speed passenger vessels of 18,000 deadweight tons, with not less than 19 knots speed, three of which will be put on the transpacific line with the intention of challenging the fast service of the Canadian Pacific from Vancouver to Yokohama. The Canadian Pacific at present makes the trip in nine days, and the new Japanese ships are intended to make trips to a United States port instead of the British Columbia terminal in the same time.

Japanese officials who were sent to Europe and America several months ago to study shipping questions and prospects are expected to make a report which will result in a new shipping subsidy bill which will give Government assistance to new lines which were opened during the war. This will result in placing subsidized tonnage on many routes where it has not hitherto been seen.

Details of the Nippon Yusen Kaisha programme follow:

Oversea Traders—	Vessels
(a) Superior high-speed passenger vessels	6
(b) High-speed cargo vessels, 12,000 tons	5
(c) 10,000-ton type cargo vessels	18
(d) 8,000-ton type cargo vessels	2
(e) 6,000-ton type cargo vessels	5
Total (382,000 tons)	36
Coasting Traders—	
(f) High-speed passenger vessels	2
(g) 2-3,500-ton type intermediate vessels	13
(h) 5,000-ton type cargo vessels	10
3,000-ton type cargo vessels	7
Total (133,000 tons)	33
Grand total (515,000 tons d.)	69

(a) Out of the six, three are intended for the Pacific service, each being superior high-speed passenger vessels of 18,000 tons gross and 19 knots; the other three are for the European service in place of the steamers lost by submarines, viz.: *Yasaka Maru*, *Mizumaki Maru* and the *Hirano Maru*, and they will be of the *Katori Maru* type. (b) All five are to be placed on the West Coast of America service. They will be 12,000 tons deadweight, and they will have a speed of 14 knots. (f) Two of this type are of 5,000 tons each, and are intended for the Shanghai-Japan service.

NEW SHIPYARD EXPECTED

American Bridge Company Looking for a Delaware River Site

Wilmington, Del., Dec. 30—[Special].—From an authentic source it is learned that the American Bridge Company is looking for a site along the Delaware River to fill a contract for the construction of a special class of boats. A representative of this company was in this city recently and talked with a number of owners of river front property, the company not looking to purchase a property, but, rather, to effect a long-term lease. Sites in this city and Eddystone have been recommended, among them the Pennsylvania Iron Works plant in Eddystone, and the unused part of the Chester Tube Company.

The statement is made that the enterprise will give employment to several thousand persons for at least a year on contracts already on hand, and before that time is up others are expected, which will mean a permanent plant, adding much to the industrial hive along the river. It is understood that the boats to be built are of the type of canal craft, similar to lighters used for heavy transportation.

An effort was made to confirm the rumor at the Edge Moor plant of the American Bridge Company, but without success. For some time it has been reported that another shipyard was in prospect along the Delaware River between Chester and Wilmington, but whether the present rumor has any connection with this is not known.

American Line Gets Two

Two of the former German passenger vessels, the *America* and the *George Washington*, have been allocated to the American Line of the International Mercantile Marine. Both are to be run between New York and Southampton via Brest and Cherbourg.

Neither vessel has as yet been turned back to the Shiping Board by the War Department. Both have been in the transport service between this country and France. It is expected that it will be considerable time before they can be reconditioned for service. The *America* has a deadweight tonnage of 21,810 and the *George Washington*, 13,300.

HAS LAUNCHED 102 SHIPS

Submarine Boat Co. Claims World's Record

Claiming that it made a new world's ship building record, the Submarine Boat Corporation launched three ships, the *Haslehurst*, the *Tashmoo* and the *Suwied*, at its Newark, N. J., yards on Saturday last. These bring the number of ships launched for the Shipping Board at the yard to 102 since its opening on Memorial Day, 1918. The total of deadweight tons is 545,700.

"No yard in the history of modern shipbuilding has even approached this record," said Henry R. Sutphen, vice-president of the company.

The *Haslehurst* was named for Henry Haslehurst Carse, son of Henry R. Carse, president of the corporation. Mrs. H. R. Carse was sponsor. Mrs. Charles Lanier, 2d, sister-in-law of R. B. Lanier, a director of the corporation, named the *Tashmoo*. The *Suwied* had a sponsor Mrs. Charles H. Hampton, wife of a vice-president of the Hanover National Bank, of which Henry R. Carse was once president.

Many New York people were in the crowd that attended the launching. On each of the ships was a phonograph with three records, one in English, one French and one Spanish, telling the history of fabricated ships.

BAYLES SHIPYARD SOLD

Arthur Allen Pays $2,225,500 for Port Jefferson Plant

The Bayles Shipyard, at Port Jefferson, L. I., has been sold by the Emergency Fleet Corporation for $2,225,500 to Arthur Allen, who has been connected with the Shipping Board for some time as assistant to Robert L. Hague. He has not indicated what disposition will be made of the vessels now building at the yard, four 5,000-ton deadweight cargo carriers, or the use to which the plant will be put in the future.

The ships being constructed at Port Jefferson are practically the same as those being produced at the Newark yards of the Submarine Boat Corporation, except that the Bayles ships will have reciprocating engines, while the Submarine Boat types are being equipped with turbines. The Port Jefferson yards have an area of about 7½ acres with four launching ways.

Will Sell Machine Tools

The War Department has entered into a contract by which the French Government is permitted to purchase $25,000,000 worth of machine tools from the surplus stocks of such tools held by the War Department in the United States. The French Government is to pay for such tools as it may purchase in ten-year 5 percent bonds of the French Republic, which at maturity are payable in dollars in gold coin of the United States.

"GET-TOGETHER" PLAN HELPS BIG SHIPYARD AND ITS MEN

Harlan Plant at Wilmington, Del., Reduces Costs and Speeds Up Production Through Co-operation—Result, Work Ahead for Next Two Years

Wilmington, Del., Dec. 23 (Special).—The conservation campaign which was recently instituted by E. B. Germain, general manager of the Harlan plant of the Bethlehem Shipbuilding Corporation, to reduce the overhead cost of building ships and give faithful employes of the plant an incentive to increase the output of the yard and make it a standard bearer for the industry in the United States, has been a wonderful success.

This plan was put up to the men as something that meant not only their individual jobs, but also meant whether the company was to be able to continue in business. At the signing of the armistice, the Harlan plant had the highest cost production of any plant in the country, and in the little over twelve months intervening that expense has been reduced, until to-day it is the lowest in the United States as regards the cost of production per vessel. This has meant the obtaining of contracts which will employ the plant at top capacity for 1920, and assured contracts which will mean work for all during 1921, with others in sight.

During the war the plant employed about 7,000, and this has been reduced until now there are about 4,300 workers, turning out practically the same amount of work in a much better manner, the output being in every way shipworthy and able to pass the severest tests of the Government. This has meant the elimination of many "ribbon clerk" and "work or fight" employes, who entered the yard to escape war duty in the trenches when the "work or fight" order was issued.

Slackers have no place in the yard now, and this is due to the efforts of Mr. Germain and his staff of supervisory heads. The feat was accomplished by impressing on the men that capacity output meant the life of the corporation—their jobs and their family's welfare—and was brought about without a single change in the superintendents and foremen, other than the few who resigned of their own accord.

Through the weekly paper of the plant, the *Harlan News*, and weekly meetings of the foremen and superintendents with Mr. Germain and the executive officers, the fact was brought home to the men that the costs must be brought down. Facts and figures were produced which brought home to the men themselves just what the corporation was up against, and soon the men saw that unless the slackers were weeded out something drastic was likely to happen.

The fact that a loafer on the job was more the business of the man who was willing to work than of the boss, and should be gotten rid of before his idea permeated the entire staff and caused a shutdown, caused the real workers to join with the management in cleansing the plant of such ilk. This was accomplished, in a manner, through a cutting down of the late list and a suspension of "holidays," which were almost a matter of necessity, it appears, to a large percentage of the force. Wet weather suspension was also done away with completely. Attendance charts were drawn up, and in a final solution, only those men who appeared for duty every day are now working.

The showing of the plant has made it a fact that the local management has been assured of contracts for the construction of two 10,000-ton tankers for the Sinclair Oil Company, of Pittsburgh, and of a share in the construction of eight 8,500-ton tankers for an English firm, a representative of which is now on the way to this country to sign contracts with the Bethlehem Corporation. The men and officers of the local plant have been assured of a proportionate share of these contracts as a reward for the manner in which the cost production price has been cut down.

The foremen, since the inception of the campaign, meet every day at lunch with Mr. Germain and the superintendents and executive officers, where troubles and puzzles in the work are talked over, and views of all obtained when a particular perplexing question arises. This has been found one of the best means of showing in which way to decrease cost of production.

There is no labor unrest at the plant and never has been. Every man is willing and ready, and, in fact, anxious, to give his full 8-hours time for the money which he has been receiving for months past. Bolsheviki and I. W. W. radicals and such like are an unknown quantity in this happy family.

The whole scheme has been figured down to this: "Our business is your occupation. Do you want your job? If so, help us to lower the production cost so that we can bid successfully with other great shipbuilding firms of the country. If not, then let's close down, for we can't operate on wind."

NEW KERR S. S. OFFICES

One in San Francisco and One on Jan. 1, In Galveston

Some significance is attached to the announcement by the Kerr Steamship Co. that offices have been opened in San Francisco, as it is in line with its purpose to develop its transcontinental service, and this may mean that the company will enter the Pacific trade from Pacific ports. The San Francisco office will be in charge of Victor M. Smith, formerly general freight agent of the company in this city. He is now Pacific Coast manager for the company.

Simultaneously with the announcement of the opening of the San Francisco offices came the news of a Kerr Steamship Company office at Galveston, to be opened on January 1. From this new headquarters the Kerr interests radiating from Galveston and other Texan ports will be looked after by Thomas Rice, who will have charge at Galveston. Mr. Rice is well known in shipping circles in the Gulf region, having for some time managed the Port Arthur and Mobile offices of several large shipping companies.

Yard of Moore Shipbuilding Co., Oakland, Cal., Where Six Vessels Were Launched on One Tide, Saturday, Dec. 20, 1919, Making a World's Record.

BIG CHRISTMAS BONUSES BY STEAMSHIP COMPANIES

Liberality in Rewarding Employees Reflects Prosperity During 1919—Kerr Line Plans Profit-Sharing—Green Star Has Big Expectations

That the large steamship companies of New York were prosperous during the year just ended was shown plainly by the extent of the bonuses and annual rewards paid to their employees Christmas. Practically all the steamship lines took part in the distribution in some form or other, and the extent of the gifts gave rise to the rumor that they were in some measure due to the decision that the employees might as well have the money as for the companies to turn it over to the collector of the excess income tax.

Executives of the larger concerns, who directed the movements of ships and governed the affairs of the companies, in some cases received as much as 100 percent of their salaries, but generally the bonuses ranged from 10 percent upward, the bonuses being based on a discriminative plan, taking into account the length of service, results obtained and the value of the office. No estimate has been made of the amount distributed, as the action was, of course, confidential, but it is a safe assumption that New York shipping circles never before have had such a Christmas.

Employees of the subsidiaries of the Atlantic, Gulf & West Indies Steamship Line were made happy when the presidents of the respective companies—the New York & Porto Rico Steamship Company, the Clyde-Mallory Steamship Company, the New York & Cuba Mail Steamship Company, the Southern Steamship Company, and the Atlantic, York & West Indies Line—informed them that the company had ordered distributed a bonus ranging from 10 to 50 percent.

The Kerr Steamship Company announced that it had put a profit-sharing plan into operation on Christmas Eve. The bonuses ranged from 10 percent upward. Some of the executives, who have been with the company for a long time and who have rendered especially valuable services, received gifts that exceeded 50 percent of their annual salaries.

The employees of the Green Star Steamship Company received a bonus of from 15 to 30 percent of their salaries. In making the announcement, H. H. Benedict, traffic manager, said: "By the time another holiday season rolls around the Green Star Corporation will no doubt be operating more steamers than any other concern flying the American flag."

The Luckenbach Steamship Company is reported to have declared a 50 percent bonus to its employees.

It was learned that Furness, Withy & Company authorized a melon-cutting with its many employees, but the percentage or the total amount of the Christmas bonus was not announced.

The Barber Steamship Company declared a bonus that ranged from 10 percent upward, and the award caused a lot of good feeling among the workers in the offices.

Neither the Cunard Line nor the International Mercantile Marine Company authorized a bonus or a sharing of profits at this time. It is understood to be the policy of the International Mercantile Marine to pay salaries that are commensurate with the value of the services performed, rather than distribute the profits in the form of bonuses. It claims to pay the biggest salaries of any steamship company in this country. The Cunard Line during the past few years has generally shared its profits in November and May.

INTENDS TO SPREAD OUT

National Motor Boat Show to Exhibit Heavy Machinery

The 1920 National Motor Boat, Ship and Engine Show will be held in Grand Central Palace, New York City, opening Friday, February 20, and closing Saturday, February 28.

Many exhibitors in the Motor Boat Shows of past years have shown only some of the proportionately smaller work that their particular yards or plants were capable of turning out. The influence brought to bear upon the industry by the necessities of war-time production, the commercial work that has been so successfully handled by many builders and manufacturers, and the unlimited possibilities that this newer and larger work have opened up for the boat building industry and its affiliated lines—all of these have been duly noted.

It has therefore been decided that, at the coming Show, exhibitors are to be given an opportunity to show the public not only pleasure boats and their equipment, but also some of the larger work that they are doing. Builders of the largest types of vessels will be encouraged to make such exhibits as the limitations of exhibit space may permit. Larger propulsion machinery, marine hardware and accessories will be shown by the manufacturers who have heretofore confined themselves to an exhibit of only that part of their output applicable to pleasure boat construction.

John J. Amory, of the National Association of Engine and Boat Manufacturers, Inc., is chairman of the exhibition committee.

G. A. FULLER CO. TO BUILD

Takes Over the Carolina Plant, at Wilmington, N. C.

The Carolina Ship Building Corporation's plant at Wilmington, N. C., has been purchased by the George A. Fuller Company, which began operation of the plant on January 1. The shipbuilding corporation was a subsidiary of the Fuller Company, incorporated for the purpose of executing a contract for the construction of the plant and of twelve 9,600 deadweight ton cargo steamers, equipped with reciprocating engines. Under the new arrangement the Fuller Company will complete eight of the twelve ships named in the contract for the Emergency Fleet Corporation for a lump sum price, and will build the remaining four of the ships for its own account and for sale. The plant is on the Cape Fear river, on fresh water within three miles of the city of Wilmington. There are four concrete ship ways, each 450 feet long, and the plant is complete except for facilities for the building of engines and boilers.

This is the first of the United States Shipping Board's yards to be sold to private interests, and it is believed that the venture of the Fuller Company into the shipbuilding industry will be of widespread interest. Paul Starrett is president of the company, and the officers in charge of the shipbuilding work will be: Lorenzo C. Dilks, vice-president; Ralph Starrett, works manager; Henry Vogt, assistant secretary and treasurer; J. R. Preston, technical manager; E. G. Glass, supply manager.

UNITED FRUIT TO RESUME

Eleven Special West Indian Cruises Arranged

Plans have been completed for the resumption of passenger service of the United Fruit Company. For the first time in five years tourists who have made the Caribbean their winter objective are eagerly making reservations for the series of eleven special cruises that will be begun early next month.

To win even more distinction for its famous Great White Fleet, the United Fruit Company announces that two new vessels will make their maiden cruises in conjunction with the steamers *Calamares* and *Pastores*. The new steamers are palatially fitted, and a private bath has been added to every stateroom, a feature to be found in no other vessels in the world.

Built by Workman, Clark & Company at Belfast, and named the *Ulua* and *Toloa*, the new steamers will partly replace the tonnage lost during the war. Because of their staunchness and adaptability the *Pastores* and *Calamares* were requisitioned for transport service in the early days of the war.

These vessels have all been overhauled by the Robins Dry Dock & Repair Company.

BUSINESS NOTES

H. W. Philbrook, formerly with the General Electric Company, Schenectady, N. Y., has been appointed district manager of the Schutte & Koerting Company's New York office, 50 Church street, New York.

Earl E. Eby, sales manager of the Hyatt Roller Bearing Company in the Industrial Bearings Division, has been appointed one of the directors on the board of Hyatt, Ltd., a new company formed to market the Hyatt bearing in Europe. Mr. Eby's office will be located in New York.

G. O. Helmstadster, formerly Chicago district manager of the Hyatt Roller Bearing Company, has been made sales manager of the company as a result of the vacancy formed in this department by the new position assumed by Earl E. Eby.

The Chicago Pneumatic Tool Company, Fisher Building, Chicago, Ill., announces the location of its new office at Birmingham, Ala., at 1926 Fifth avenue, North.

The Jacobson Engineering Company, Inc., Albany, N. Y., at opened an office at 30 Church street, New York. This will be the main sales office for both domestic and export business. This company is the sole agent for the Jacobson Crude Oil engine built by the Jacobson Gas Engine Company, Albany, N. Y., also direct factory representative for builders of gas engines, gas producers, Diesel engines and all kinds of automotive machinery.

On January 1 the sales and contracting business formerly carried on by the General Fire Extinguisher Company was taken over by a new concern—Grinnell Company, Inc. The change was made because the old name so specifically described the automatic fire protection section of the company's business that it prevented the understanding on the part of the public that the company's business is based fundamentally on industrial piping, and that it is perhaps the largest concern in the United States doing exclusively that sort of work. The Grinnell Company offers a complete engineering and construction service in the whole field of industrial piping, including sprinkler, heating, power and drying work, and prompt sales service in material for all such equipments. In certain sections of the country this sales business has been expanded to include mill and plumbers' supplies. The executive offices of the company are 275-301 West Exchange street, Providence, R. I.

The Reading Iron Company, Reading, Pa., has acquired the plant of the E. & G. Brooke Iron Company, at Birdsboro, Pa. This acquisition adds to the already extensive equipment of the Reading Company 16 double puddling furnaces, with a three-high double muck mill, 24-inch three-high skelp mill with four heating furnaces, and a nail factory of 75 nail machines—the latter long known as one of the landmarks of the Eastern Pennsylvania iron industry. Through this addition to its manufacturing facilities, the Reading Iron Company's skelp capacity is increased by 2,800 tons per month, with a corresponding increase in the production of finished wrought iron pipe. The company is undergoing reorganization under the direction of L. E. Thomas, who succeeded F. C. Smink as president.

Frank O. Wells, president of the Greenfield Tap and Die Corporation, and one of the prominent figures in the screw thread industry in the United States, has sold his entire holdings to Frederick H. Payne, vice-president. Mr. Wells retires as president and member of the board of directors, and Mr. Payne has been elected president in his place. F. G. Echols, vice-president and general manager, has been elected as director to fill the vacancy caused by the resignation of Mr. Wells, who will remain with the corporation in an advisory capacity.

The American Engineering Company announces the appointment of Mr. Fayette A. Cook as district representative, Marine Products, in the Great Lakes district. This company's marine products include steering gears, telemotors, windlasses, capstns, gypsies, winches, towing machines, and marine chandlery. Mr. Cook is qualified to discuss the application of any marine auxiliaries, as well as to handle all requirements for repair parts. He will be located in Cleveland, with offices at No. 1111 Citizens' Building.

The Rotary Scraper Co., Inc., has removed its offices to No. 39 Broadway, New York City.

Mr. Comly B. Shoemaker, Jr., has been appointed assistant superintendent of the Roe puddling department of the Reading Iron Company.

The American Balsa Company, 50 East 42d street, has added to its staff Dr. M. E. Pennington, formerly chief of the Food Research Laboratory of the U. S. Department of Agriculture. He will be manager of the research division of the Balsa Company.

The Van Dorn Electric Tool Co., of Cleveland, Ohio, has added to its plant a new four-story building, with 30,000 additional feet of floor space. The entire plant is given over to the manufacture of portable electric drills, reamers and grinders, the great demand for these tools resulting from the widespread recognition of their superiority over cumbersome and expensive methods required in handling material in the past. Wherever electric current is available the Portland Electric Tool "goes to the job." During the war an extensive use was made of the Portable drill in ship building, and one application was its suspension in a light "buggy" frame, being moved from place to place to counterbore rivet holes in ship plate.

The Hooven, Owens, Rentschler Company, of Hamilton, Ohio, have opened two new offices and made some changes in the personnel of their other offices. An office has been opened in Philadelphia at No. 2129 Land Title Building, with Mr. C. M. Becker, formerly with the R. D. Wood Company, as manager. Richmond, Va., has a new office, with Mr. E. H. Fairchild, formerly of the C. & G. Cooper Company, in charge. Henry E. Balsley, formerly with the American Bridge Company, has been placed in charge of the Chicago office. E. S. Cooley, formerly with the Fall River Shipbuilding Company, has been added to the New York office staff, and R. C. Holman, formerly with the General Electric Company, has been placed in charge of all blowing engines.

New York Shipbuilding Corporation Buys Yard

Announcement has been made that the New York Shipbuilding Corporation has arranged to purchase from the United States Shipping Board four concrete ways, comprising the South Yard, which was built by the company during the war for the Emergency Fleet Corporation. The yards were constructed at a cost of approximately $5,000,000, but nc price is mentioned as being paid for the South Yard.

The New York Shipbuilding Corporation is building a fleet of sixteen combination cargo and passenger ships for the Emergency Fleet Corporation. Nine of these are of the 585-feet type, with a speed of 18 knots, and seven are of the 503-feet class.

OBITUARY

WILLIAM M. EVANS

William M. Evans, vice-president of the Alabama Dry Dock and Shipbuilding Company, the pioneer steel boat bullder of Mobile, died December 25, at the hospital of the plant that he was connected with. Shortly before noon he was striken with heart trouble, and gradually grew weaker until the end.

Mr. Evans came to Mobile twenty-five years ago from Columbia, S. C., as an employee of the boiler shop of the Louisville and Nashville Railroad. He organized the Gulf City Boiler Works and built the Ruth, the first steel tugboat turned out at Mobile for the Texas Company. The boiler works was merged with the Alabama Dry Dock and Shipbuilding Company, and he was made vice-president of the company and all the steel work of the big ship plant was under his direction.

He is survived by his widow, Mrs. Mattie T. Morrison Evans; six children, his parents, three brothers, one sister, and other relatives. Mr. Evans was a member of Rescue Lodge, Knights of Pythias, Howard Lodge of Masons and Abba Temple, Mystic Shrine.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIP CONTRACTS

The Downey Shipbuilding Corporation, New York City, has closed contracts with the Southern Pacific Company to build three 12-knot steel steamships, length over all 352 feet, molded beam 47 feet, molded depth to hurricane deck 32 feet 6 inches, mean loaded draft 23 feet. Propelling machinery will be triple expansion reciprocating steam engines, Scotch boilers, oil burning. The auxiliary and general equipment of these three steamships will be of the highest class, in accordance with the practice of the Southern Pacific Company.

The Staten Island Shipbuilding Company, Mariner's Harbor, Staten Island, N. Y., has received a contract from the Tidewater Oil Company for one steel tanker. The vessel will be about 2,000 tons deadweight, 228 feet 6 inches over all, 37 feet 6 inches beam, and 17 feet depth, forward shear 3 feet 9 inches, shear aft 1 foot 9 inches. Her engines are vertical inverted direct-acting, triple expansion, with cylinders with 15 by 24 by 48 inches, stroke 28 inches. Under working pressure of 180 pounds per square inch they will develop about 750 horsepower, giving a speed of 10½ knots. The company has also received a contract from the Galena Oil Company for one steel tanker. The vessel will be 4,000 tons deadweight, 304 feet over all, 294 feet between perpendiculars, 42½ feet beam, 26 feet deep, 19 feet to second deck. She will be equipped with triple expansion engines, with two Scotch boilers and have an estimated speed of 11½ knots.

Six Tankers, Bethlehem Shipbuilding Corp.—The Harlan plant of the Bethlehem Shipbuilding Corporation has been advised that the parent company has received tentative contracts for the construction of six tankers, two of 10,000 tons each and four of 8,500 tons each. The former are larger than any vessels previously built at the local plant, and are intended for the Sinclair Consolidated Oil Company. The second group are to fill an English contract.

Oil Carriers, Bath, Me.—At the mammoth plant of the Texas Steamship Company, which came to Bath five years ago, and where several bulk oil carriers of 10,000 tons have already been built, four more are under construction, in addition to many smaller craft, such as harbor boats, barges, scows and towboats, all for the company's own use.

Wooden Schooner, Bath, Me.—Percy & Small, Inc., Bath, Me., are building a wooden schooner in their yard, and are repairing two big schooners built by them, but sold during the war to the France & Canada Steamship Corporation.

Large Passenger Liner, Seattle, Wash.—Plans and specifications for what will be the largest and fastest passenger liner plying Pacific waters have been submitted to the shipbuilding concerns of the Coast by the Pacific Steamship Company, of Seattle, Wash., A. F. Haines, general manager. The liner now under contemplation will be nearly 600 feet in length over all, being 560 feet between perpendiculars, and the width will be slightly over 80 feet. Propelled by electric drive and 20,000-horsepower turbines, the contract will demand a sustained sea speed of 22 knots an hour. This will be the fastest electrically-driven steamship in the world, the speed of dreadnoughts of the New Mexico class being 1 knot less.

Three Tankers, Portland, Ore.—The G. M. Standifer Construction Company, Portland, Ore., has received a contract for three oil carriers for the Standard Oil Company of New Jersey.

Oil Tankers, Quincy, Mass.—The first keel on a contract for the Standard Transportation Company, of New York, calling for four 12,500-ton oil tankers, was laid at the Fore River yards at Quincy, Mass. A similar ship will be built for the Atlantic Gulf & West Indies Steamship Company. They will be equipped with quadruple expansion engines of 3,000 horsepower, which will be built at the same yards.

The Moore Shipbuilding Company, Oakland, Ore., has received a contract for three oil carriers for the Standard Oil Company of New Jersey.

The Moore Shipbuilding Company, Oakland, Calif., has received a contract for a 10,000-ton tanker for the Vacuum Oil Company of New Yor. The ship will be 425 feet long, 57 feet beam, with a capacity of 72,000 barrels of oil. She will have Scotch boilers and a triple-expansion engine, and the contract calls for delivery in June, 1921.

The Standard Shipbuilding Corporation, 15 Whitehall street, New York, has been awarded a contract to construct two special type combination fruit and passenger ships for the Cuyamel Fruit Company, of New Orleans. Delivery has been guaranteed for the last of next May and June, and construction will be begun immediately. The steamers will be 235 feet long, 34 foot beam and 15 feet deep, with a speed of 11 knots and accommodations for 30 passengers. It is considered probable that they will cost more than $500,000 each.

Gielow & Orr, yacht designers, have finished plans and are to place the contracts for the construction of a large steam yacht, to cost about $750,000, which will be owned by the president of the Dodge Bros. Automobile Company.

The Murnan Shipbuilding Corporation, Mobile, Ala., has received a contract for ten barges for the Government to be used at Muscle Shoals, near Florence, Ala.

Steel Steam Yacht Overhauled, Portland, Me.—The steel steam yacht Colonia, belonging to President George D. Dearborn, of the American-Hawaiian Steamship Company, has been hauled out on the marine railway for extensive repair, and will probably remain there all winter.

Robert Jacob, City Island, New York, it is announced, has received a contract from Vincent Astor for a yacht smaller than his yacht Noma, which he sold to Rodman Wanamaker. The new vessel will be only 150 feet long, and will be driven by a Winton heavy-oil engine of 700 horsepower.

Commercial Power Boats, Bay City, Mich.—The De Foe Boat & Motor Works Company, Bay City, Mich., is building several commercial power boats for use on the inland lakes of Mexico. One of these vessels is 68 feet long, 14 feet wide and capable of carrying passengers and cargo. The boats are being shipped in sections. They have engines of 35 to 85 horsepower, capable of producing a speed of ten miles an hour.

Lifeboats, Mobile, Ala.—The Mobile Steel Company, Mobile, Ala., which has just finished fourteen steel lifeboats for the International Shipbuilding Company, is building ten for the Alabama Shipbuilding Company, and twelve for the Federal Shipbuilding Company.

Four Submarines Purchased, New London, Conn.—T. A. Scott & Company, New London, Conn., submarine engineers and wreckers, have bought the destroyers, Reid, Flusser, Preston and Lamson from the United States Government. The vessels, which are at the Philadelphia navy yard, are to be brought to this city in a few days. They will have a thorough overhauling, which will include the installation of Diesel engines. The destroyers are all of the coal-burning type. It is understood that the Scott Company will sell the boats.

Concrete Oil Barges, Tampico, Tex.—So much success was met with the recent construction at Tampico, Tex., of a concrete oil barge for the Atlantic, Gulf & West Indies Steamship Company that other barges will be built as rapidly as possible. The keel of a second vessel of this kind has been laid. This barge was constructed of volcanic ash, is 80 feet over all and has 20 feet beam, 6 feet depth, 10 watertight compartments and draft of 20 inches. It has a capacity of 111½ tons on 48 inches draft. The only wood employed in the barge is in the fenders. There is believed to be a big future for larger vessels of this sort in the oil carrying business.

The Pusey & Jones Company, Gloucester, N. J., according to a recent announcement by William G. Coxe, president of the company, has received contracts for the construction of four 8,500-ton tankers for the Anglo-Saxon Company of London. These boats will be duplicates of several built three years ago by the Harlan plant of the Bethlehem Shipbuilding Corporation for the Shell Line.

The American Bridge Company, Pittsburgh, Pa., has contracted to build a large number of 1,000 deadweight ton oil barges for the Standard Oil Company and other oil concerns.

Sailing Vessels, Portland, Me.—At the yard of the Russell Shipbuilding Company, Portland, Me., where four Ferris type steamers were constructed, plans are being made under the management of Frank A. Rumery to build a fleet of sailing vessels on the company's own account. The first one, the four-masted schooner Ida May, 875 gross tons, was recently launched.

Passenger Steamers and Cargo Carriers, Japan.—The Japan Mail Steamship Company (Nippon Yusen Kaisha) plans an extensive building programme, including seven or eight large passenger steamers and fifty to sixty cargo carriers, and has declared a 50 percent dividend, plus a 50 percent bonus.

Cargo Carrier, Bath (Me.) Iron Works—Early this year the keel will be stretched for a steel cargo carrier for Crowell & Thurlow,

of Boston. This craft is to be a sister ship to the Felix Taussig, built at Newport News, Va., in 1915. She will be 410 feet long, 55 feet beam, 34.5 feet deep, and will displace between 13,000 and 14,000 tons, making her the largest ship, save those for the navy, ever built at this plant.

Two Steel Barges or Converted Schooner Barges, Tampico, Mexico.—The Philadelphia manager of the Atlantic Coast Shipbuilders' Association advises that a construction firm in Tampico, Mexico, is in the market for two steel barges or converted schooner barges, with cargo capacity of from 2,000 to 4,000 tons, for use between Tampico and Texas ports for bringing lumber down and carrying crude oil back. Details can be obtained from the association's Philadelphia office, in the Shubert building.

Coasting Vessels, Rochester, England.—Short Bros., of Rochester, England, it is announced, are to begin the construction of coasting vessels up to 1,500 tons to be equipped with oil engines. At present the firm is engaged in building ordinary motor boats and small rowing boats. The firm expects considerable work along the new line, and is arranging for the purchase of a large water frontage. During the war Short Bros. constructed many of the largest seaplanes used by the United States Government.

Tankers, Holland.—The Royal Dutch-Shell Transport group has purchased from the British Government oil tankers to the avlue of $50,000,000, according to announcement by Joseph Walker & Sons. The Dutch-Shell fleet has a capacity now of almost 1,000,000 tons, all of which is busy.

Steamers, Yarrow-on-Clyde, Scotland.—The Yarrow yard is building two steamers of 3,500 tons each and two small stern-wheel steamers for river use.

Coasting Steamers, Renfrew-on-Clyde, Scotland.—Two coasting steamers are on the ways at the Simons yard at Renfrew.

Passenger Steamer, Whiteinch-on-Clyde, Scotland.—A passenger steamer of 11,000 tons for the Antwerp Line is being constructed at Whiteinch by the Lloyd Royal Belge.

Ship Construction, France.—Nine mail boats totaling 97,000 gross tons, 84 cargo steamers totaling 262,000 tons, 115 tugs totaling 15,900 tons, 21 fishing boats with auxiliary motors totaling 5,870 tons, 16 sailing vessels totaling 4,420 tons, and 174 barges aggregating 119,000 tons, are on the ways in French yards for French companies.

Ten Cargo Vessels and Six Liners, France.—The French Minister of Marine, according to a Paris report, has agreed with the Commissioner of Marine Transport to build ten new cargo vessels of the Marie Louise type and six liners for the Indo-China Line in the Naval Arsenals. These vessels will not be completed before 1922. They have been assigned as follows: Cherbourg, five cargo steamers; Brest, three mail steamers; L'Orient, three mail steamers; Rochefort, five cargo steamers.

The New York Shipbuilding Corporation is building a fleet of sixteen combination cargo and passenger ships for the Emergency Fleet Corporation. Nine of these are of the 585-feet type, with a speed of 18 knots, and seven are of the 503-feet class.

The Crosby Navigation Company, Bath, Me., is to build at its plant in Richmond a four-masted wooden schooner for the E. S. Crosby Company, recently organized under the laws of Maine.

Schooner, South Portland, Me.—At the yard of the Cumberland Shipbuilding Company, South Portland, Me., work has begun on a four-masted schoner of 1,000 tons, which will be launched early in the spring. James C. Hamlen, of South Portland, president of the company has extensive business interests in the island of Martinique, and may build several good-sized schooners in this yards for his own use.

The Bethlehem Shipbuilding Corporation, Bethlehem, Pa., Joseph W. Powell, vice-president, announced on December 27, the awarding of four contracts to the Harlan plant in Wilmington, two for 8,500-ton tankers and two for 7,300-ton tankers, which is believed locally to be part of a large order received by the parent company from an English concern.

NEW SHIPYARDS AND SHIPYARD EXTENSIONS

Marine Repair Shop, Texas City, Tex.—The Gulf Marine Repair Works, Texas City, will build a marine repair shop at that port.

Wooden Shipbuilding Plant, Tacoma, Wash.—Barbare Bros., Tacoma, Wash., shipbuilders, have begun the construction of a modern wooden shipbuilding plant in preparation for an active construction programme. Their old yard will be used as a repair plant.

Shipyard Reorganization, Freeport, Me.—The Cushing Briggs Shipyard at Freeport, Me., has recently acquired possession of the Northeastern Shipbuilding & Transportation Company, and will build motor-driven oil-burning vessels of standardized type of from 1,600 to 2,000 tons each. Morris M. Whittaker is general manager of the company, which is chartered under the Maine laws, with a capital of $1,500,000.

Dry Dock and Repair Plant, Pensacola, Fla.—About May 1 next the Bruce Drydock Company, Pensacola, Fla., expect to have in operation a new 5,000-ton drydock and repair plant. The dock will have a maximum capacity of 6,000 tons, and will lift vessels 475 feet in length. The estimated cost of the dock will be $450,000. It is to be a five-section floating wood drydock, with ample capacity for handling Gulf shipping. It will be 480 feet in length over all, 94 feet beam, 78 feet 2 inches between wings, depth of pontoons 12 feet, and 18 feet over 3½ foot keel blocks. The dock was designed by James L. Crandall, consulting engineer, East Boston, Mass., and the construction contract has been sublet to the Aberthaw Construction Company, Boston, Mass.

Two 10,000-ton Floating Drydocks, Delaware.—Rumors are current of a project fostered by interests prominently connected with the Hurley administration of the Shipping Board, and supported by adequate financial backing, to purchase the two 10,000-ton floating drydocks of Emergency Fleet construction for use on the Delaware. These docks, it is understood, are now being bid for by rival New York capitalists. The docks are offered at something more than $800,000, and the terms require payment within eight years.

Shipyard Purchased, Milton, Fla.—M. M. Feishaum, of Pascagoula, Miss., recently purchased the Hoodless Shipyards at Milton, Fla. Three uncompleted three-masted schooners on the ways of the plant were sold with the yards.

Drydock and Marine Railway Purchased, Jacksonville, Fla.—The Merrill-Stevens Shipbuilding Corporation, Jacksonville, Fla., has recently purchased from the Emergency Fleet Corporation the five-section drydock and the marine railway which they have been constructing at Jacksonville. This will be put into commission soon and will be a big asset to their plant. The drydock will be able to accommodate vessels of 8,000 gross tonnage.

Shipyard Reorganization, Charleston, S. C.—All the property of the Valk & Murdoch Company at Charleston has been taken over by the Charleston Dry Dock & Machine Company, a corporation which was chartered by the State of Delaware a few months ago, with a capital of $2,500,000. The affairs of the original company, which was capitalized at $125,000, are being liquidated. W. R. Bonsal is president of the new company, while Charles R. Valk, president of the Valk & Murdoch Company, becomes vice-president. Charles V. Boykin is general manager. The Charleston Dry Dock & Machine Company now has an 8,000-ton drydock, a 1,500-ton marine railway, and boiler and machine shops capable of making any kind of repairs needed by vessels.

Concrete Foundation for Launching Ways, Bath, Me.—The Bath Iron Works, Ltd., which has for a number of years specialized in the building of torpedo boat destroyers, is planning for commercial work, and the biggest concrete foundation for launching ways in Maine is being built.

Shipyard, Port Jefferson, Long Island, N. Y.—The Bayles Shipyard, Port Jefferson, L. I., has been sold by the Emergency Fleet Corporation for $2,225,500 to Arthur Allen, who has been connected with Shipping Board for some time as assistant to Robert L. Hague.

Marine Railway, Mobile, Ala.—Frank Henderson, president of the Henderson Shipbuilding Company, Mobile, Ala., announces that his corporation intends building another marine railway at that port, the cost of which will approximate $300,000.

Shipyard Sale Confirmed, New York City, N. Y.—Federal Judge Julius M. Mayer has confirmed the sale of the plant and shipbuilding yard of the Eastern Shore Ship Building Company, 2 Rector street, New York, to John H. Smith, Salisbury, Md., for $31,000. The sale took place on October 16 at Sharptown, Md.

Shipyard, Norfolk, Va.—It is reported that the National Concrete Boat Company, 203 East City Hall avenue, Norfolk, Va., which has a small plant in that city, is to build a large shipyard for the construction of its type of concrete vessels. About $500,000 will be invested, in connection with the addition of a railway repair department to the present works. Arthur W. Duehl is this company's chief engineer, and Arthur D. Davis is president.

Shipyard Control Changed, Wilmington, N. C.—The Caroline Ship Building Corporation's plant at Wilmington, N. C., has been purchased by the George A. Fuller Company, which began operation of the plant on January 1. The shipbuilding corporation was a subsidiary of the Fuller Company, incorporated for the purpose of executing a contract for the construction of the plant and of twelve 9,600 deadweight ton cargo steamers, equipped with reciprocating engines. Under the new arrangement the Fuller Company will complete eight of the twelve ships named in the contract for the Emergency Fleet Corporation for a lump sum price, and will build the remaining four of the ships for its own account and for sale.

Shipyard Sale, Newark, N. J.—Announcement has been made that the New York Shipbuilding Corporation has arranged to purchase from the United States Shipping Board four concrete ways, comprising the South Yard, which was built by the company during the war for the Emergency Fleet Corporation. The yards were constructed at a cost of approximately $5,000,000, but no price is mentioned as being paid for the South Yard.

New Shipyard, Wilmington, Del.—From an authentic source it is learned that the American Bridge Company is looking for a site along the Delaware River to fill a contract for the construction of a special class of boats. A representative of this company was in Wilmington recently and talked with a number of owners of river front property, the company not looking to purchase a property, but, rather, to effect a long-term lease.

HARBOR IMPROVEMENTS

Deepening Channel, Philadelphia, Pa.—The United States Engineers' Department will ask bids for dredging in Philadelphia harbor to the depth of 35 feet. The work will begin in the vicinity of Pier No. 93, south, and extend up the river as far as funds will permit. The sum to be expended will amount to over $400,000.

Sea Wall, Corpus Christi, Tex.—C. J. Howard, city engineer, and Robert J. Cummings, consulting engineer, Houston, Texas, have completed surveys and presented a preliminary plan for building a sea wall into the bay at Corpus Christi. The cost is estimated at $2,900,000, the wall to be built in seven sections. A length of 600 feet is proposed, and the wall is to be twelve feet high, with an embankment rising two feet higher.

Deepening Channel, Newark, N. J.—There is a movement on foot to have the channel at Newark, N. J., deepened. While plans have been completed by ship designers for the large types of cargo carriers, it is said that no work will be started on the huge ships until the waters are sufficiently deep to permit launchings without trouble.

Eight Piers, Stapleton, S. I., N. Y.—The Commissioners of the Sinking Fund of the City of New York have adopted a resolution recommending to the Board of Estimate that the Controller be authorized to issue corporate stock of the city to the amount of $8,543,089 for the construction of eight piers at Stapleton, S. I.

$2,000,000 Pier, Portland, Me.—No decision has been made as yet by the commissioners having the matter in charge as to the site for the new State pier which is to be built at this port during 1920, at an expense of $2,000,000, but Chairman Henry F. Merrill stated that ground will be broken early in April.

New Wharves and Dredging, Tunis and Sfax.—Beginning early this year the long-delayed improvements at Tunis and Sfax will be begun, the former calling for the prolongation of the phosphate wharves, the construction of a special wharf for coal imports, the dredging of both the sailing vessel and the principal harbors, and the equipment of the docks with the most modern means for handling cargo. The improvements at Sfax will consist mainly of enlargement of the phosphate wharves.

Warehouse and Terminal, Mobile, Ala.—The city commission of Mobile has passed a resolution offering to the United States Railroad Commission one of the sand islands at the mouth of Mobile River, off Choctaw point, as a site for the proposed $800,000 coal storage warehouse and terminal which operators of the Birmingham mineral district are urging the administration to construct here.

New Piers, New York City, N. Y.— Murray Hurlbert, Commissioner of Docks and Director of the Port of New York, recently announced that the War Department has given its consent to an extension of the pier head line of the Hudson River from Pier 11 south to the Battery, which will permit the construction of a number of new modern piers.

Dock Bonds, Pensacola, Fla.—Pensacola's City Commissioners have passed the ordinance authorizing the issuance of $400,000 dock and belt line railroad bonds. It is now stated that the work will go ahead promptly, and Pensacola will soon have an up-to-date municipal wharf.

Harbor Improvements, Auckland, N. Z.—The Harbor Board of Auckland, N. Z., has obtained permission from Parliament to borrow $4,886,500 at not to exceed 5½ percent interest for harbor improvements, which will include a breakwater, wharf construction, equipment, warehouse, tide deflector, ferry wharf and reclamation work.

Port Improvements, London, England.—The London Road Board is vigorously urging the creation of a new authority to prepare a comprehensive planning scheme for the whole of the London dock and riverside area. An English writer recently declared that after visiting a large proportion of the big ports throughout the world he could safely say that London took first place in colossal inefficiency.

Port Improvements, La Pallice, France.—Improvements at the port of La Pallice, in the Rochelle district of France, have been going on steadily recently. The port is the most important one in the district for large cargo steamers, owing to the fine facilities for handling freight.

Piers, Weehawken, N. J.—The Cunard and Scandinavian-American Steamship Companies plan to build several large three-decker piers adjoining the West Shore Railroad Terminal. They will be built of concrete and steel.

Piers, Jersey City, N. J.—The Lehigh Valley Railroad, 64 Broadway, New York City, plans to build two steel lifting piers on the waterfront at the foot of Jackson avenue. Estimated cost about $300,000.

Piers, Love Point, Md.—The Peninsular Ferry Company, 702 American building, Baltimore, plans to build a 1,300-foot timber pier. Estimated cost between $40,000 and $50,000. R. T. Ford is in charge.

Marine Ways, Mobile, Ala.—The Henderson Shipbuilding Company, foot of Eslava street, plans to build a marine railway. Estimated cost about $300,000.

Dredging, East River, New York.—The United States Engineers Office, 39 Whitehall street, has let a contract for removing rocks and dredging in East River, First District, to the Arundel Corporation, Philadelphia, Pa., for $687,350.

Removing Wreck, New York, N. Y.—The United States Engineers Office, War Department, Washington, D. C., has let the contract for removing the wrecked schooner Geneva Mertis to C. W. Johnston, Brooklyn, N. Y., for $2,100.

Dredging, Harbor Beach, Mich. — The United States Engineers Office, 337 Federal building, Detroit, Mich., has let contract for dredging the main entrance to the harbor to projected depths of 21 and 23 feet to M. Sullivan, 179 Iroquois street, Detroit, for about $120,000.

Tanks, Bayonne, N. J.—The Tidewater Oil Company, Constable Hook, plans to build 15 oil tanks at tidewater on New York Bay.

Quay Wall, Norfolk, Va.—Bids will be received until January 14 by the Bureau of Yards and Docks, Navy Department, Washington, D. C., for the building of uncreosoted bearings, batter piles and creosoted fender piles and chocks, etc. Specification No. 4,044.

Wharves, Bamfield, B. C.—The Department of Public Works, Ottawa, Can., is soon to let contracts for repairing wharves in Bamfield and Ucluelet, pile and timber construction. Estimated cost about $30,000. A. Lafhuer, Ottawa, is in charge.

Breakwater, Meteghan, N. S.—Bids will be received until January 21 by C. S. Desbrochers, Secretary of the Department of Public Works, Ottawa, for rebuilding an ell to the main breakwater.

Piers and Docks, Baltimore, Md.—The Spedden Shipbuilding Company and the Canton Lumber Company have let contracts for rebuilding timber and concrete piers and docks on Boston street at the foot of Kenwood avenue, to A. Miller, of 3122 Foster avenue. The total cost will exceed $250,000.

East Jetty, South Pass, New Orleans, La.—The United States Engineers Office Custom House, New Orleans, has let a contract for furnishing and placing 25,000 tons of stone and 5,000 cords of willow brush along the inner East Jetty at South Pass, Miss., to L. F Alexander, Audubon Place, New Orleans. Cost, $226,500.

SHIPPING DEVELOPMENTS

Twenty-seven Wooden Barges Purchased, Baltimore, Md.—It was announced recently that the sale of twenty-seven wood barges owned by the Shipping Board had been made to W. B. Duke and associates of Baltimore. The transaction involves approximately $1,458,000. The barges, of 2,500 tons each, were sold at $54,000 each. Terms were one-third of the total amount cash payment, one-third within six months, and the remaining one-third within twelve months.

Shipbuilding Company, New York.—The Atlantic Marine & Construction Company, has recently been incorporated with a capital of $2,000,000, to build boats. The incorporators are: Herbert S. Bain, C. S. Boech and J. Dowsany, all of New York.

Steamship Reorganization, New York.—Announcement has been made at the office of the Clyde Steamship Company that the company had acquired the steamship interests of Edward M. Raphel & Company and the Raporel Steamship Line. The Raporel Line will continue operation as heretofore, with its offices at 17 Battery Place.

Power Company, Newark, N. J.—A company under the title of the Stein International Power Company has been incorporated in New Jersey, with a capital of $500,000, with the announced intention of manufacturing wave power air compressors, apparatus and machinery. The offices of the company are at 790 Broad street, Newark, N. J.

Schooner Purchased, Providence, R. I.—The two-masted schooner A. G. Pease, recently hauled out and practically rebuilt on the East Providence drydock, has been sold to Manuel Court, of Providence, R. I., who will fit her out for a voyage to Brava, Cape Verde Islands. This is the second schooner Mr. Court has bought for the Brava trade within a year.

Merchant Vessel Sold, Argentina, S. A.—The first merchant vessel of any considerable tonnage ever built in Argentina has recently been sold by the builders, the Astilleros Escandinavo-Argentinos (Scandinavian-Argentina Shipping Yards), located on the Tigre river, a few miles from Buenos Aires. The yards of this company make the construction of much larger vessels practicable, and August Johnson, the president, has announced that the company will at once undertake operations on a larger scale.

GOVERNMENT SALES

Three Steam Propelled Vessels, New York City.—The Director of Sales announces that the Transportation Service of the Army is offering for sale under sealed proposals three steam propelled vessels, now in the port of New York, bids for which will be received by the Port and Zone Transportation Officer, 45 Broadway, New York City, until 10 o'clock A. M., January 15, 1920. The three vessels to be offered for sale are the wooden tug, Alpha, the wooden freight and passenger vessel, Bronx, and the wooden freighter, Long Island. Inspection of these vessels may be made by applying to the Officer in Charge of Vessels' Operations, Room 705, 45 Broadway, New York City. Further information regarding this sale may be obtained from the Port and Zone Transportation Officer, 45 Broadway, New York City.

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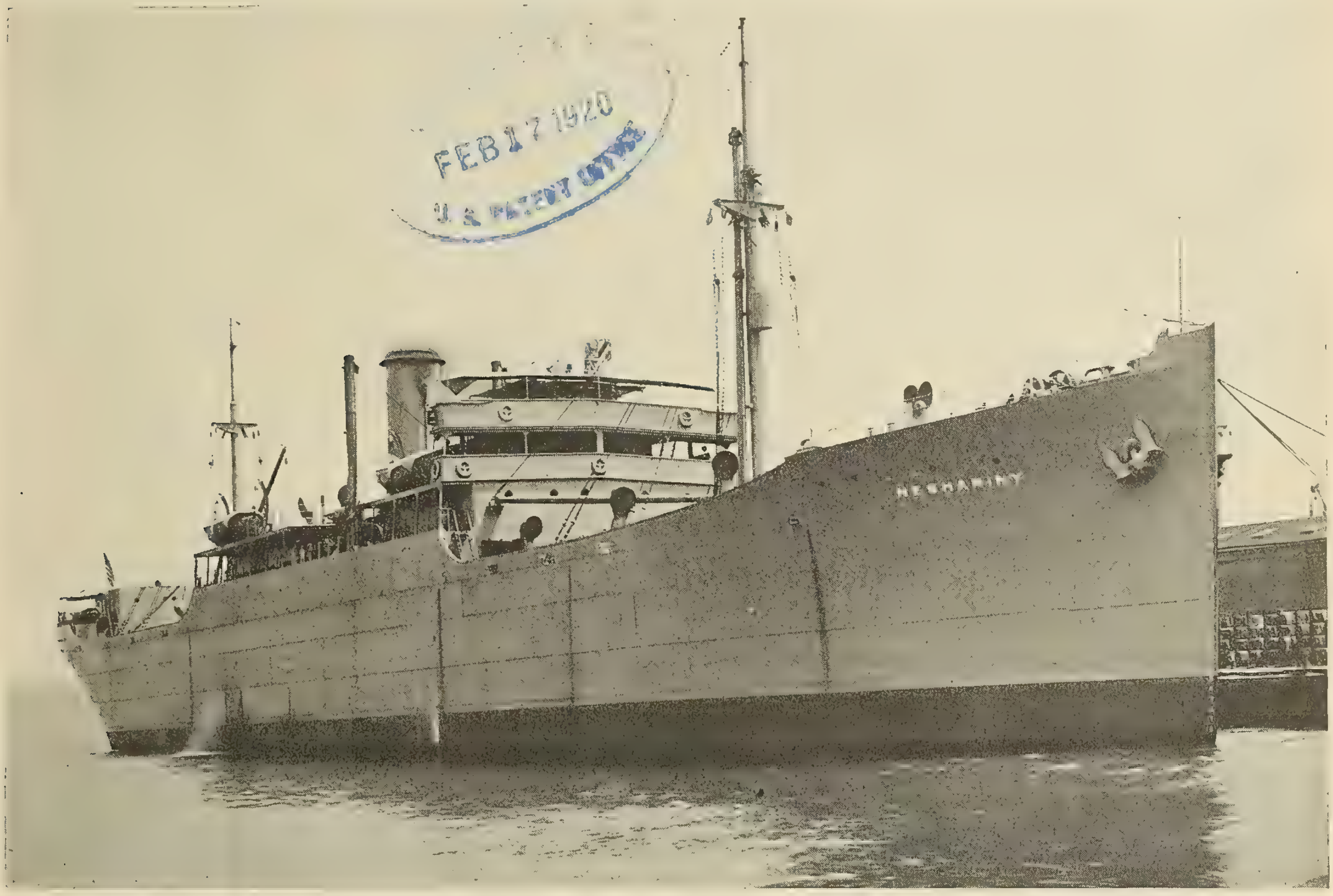


Fig. 1.—S. S. *Neshaminy*, Equipped with Westinghouse Machinery, at a Philadelphia Pier Ready to Take Her First Cargo

Westinghouse Propelling and Auxiliary Machinery Installed in Fabricated Ships

BY P. M. ROBINSON*

When the United States entered the war early in 1917 it was necessary for the Navy Department to requisition a large proportion of the capacity of the "old line" shipyards, where the expert knowledge for the building of naval craft was available, and as a result the capacity remaining for building merchant vessels, the demand for which was enormous, was comparatively negligible. To meet this great need for transport tonnage, the plan was conceived to utilize the industrial plants of the country for manufacturing the various parts of the ships and to construct shipyards where these parts could be assembled. The introduction of this idea, which had long been applied to other structural work, into the shipbuilding industry marked the beginning of the era of the "fabricated ship."

AMONG the various assembling yards which were built during the war for the construction of "fabricated" ships is the one located at Bristol, Pa., on the Delaware river, known as the Merchant Shipbuilding Corporation. The site for the yard was purchased by the Harriman interests, who became agents of the United States Shipping Board Emergency Fleet Corporation, and work was started in September, 1917, although the actual contract was not signed until October, 1917. Already located on the site were a few buildings taken over from the Standard Cast Iron Pipe and Foundry Company, but the remainder of the property consisted of open fields and meadows.

Eleven months from the time that work was started the

* Marine engineering department, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

first vessel was launched, and at the end of two years fourteen completed ships had been turned over to the operating division of the Shipping Board.

Method of Fabrication

Practically all of the steel work in the vessels built by the Merchant Shipbuilding Corporation is fabricated by the American Bridge Company, and as nearly as can be estimated 83 percent of the work is fabricated ready fo assembly before it reaches the yard. Keels, frames, bulkheads, shell plates and super-structures are all cut, bent, punched and riveted together in as large units as can be transported and economically handled.

The main propelling units, together with the principal engine room auxiliaries, are supplied by the Westinghouse Electric & Manufacturing Company. The boilers are furnished by the Babcock and Wilcox Company.

Inasmuch as such a large part of the work is completed when the various parts reach the yard, the equipment required in a fabricated shipyard is very much simpler than that usually found in a shipbuilding plant, consisting of the following:

(1) Launching ways, with the necessary crane facilities and other adjuncts.

(2) Fitting-out docks, with the necessary cranes and transportation facilities.

(3) Storehouses and storage yards for the storage of the untold number of parts.

(4) A few small shops for doing miscellaneous work in connection with the completion of the ships.

(5) Sufficient fabricating capacity to complete the ships, rectify errors, etc.

In the Merchant Shipbuilding Corporation yard there are twelve launching ways, and it is estimated that one complete boat can be turned out every fifteen or twenty days, although this schedule has not yet been attained. The present deliveries are at the rate of approximately eighteen ships per year.

General Description of the Vessels

The vessels built by the Merchant Shipbuilding Corporation are single-screw cargo boats of about 9,000 tons capacity, the general dimensions of which are as follows:

Length overall	417 feet 8 inches
Length between perpendiculars	401 feet 0 inches
Beam, molded	54 feet 0 inches
Depth, molded	32 feet 10 inches
Designed draft, light	7 feet 8 inches
Designed draft, loaded	25 feet 2 inches
Block coefficient	.79
Displacement, light	3,403 tons
Displacement, loaded	12,225 tons
Deadweight carrying capacity	8,822 tons
Designed speed	11 knots
Cubic capacity (including hold No. 3, 'tween deck side bunker and bridge bunker)	476,205 cubic feet
Fuel oil capacity (38 cubic feet per ton)	1,140 tons
Fresh water capacity, potable	25.7 tons
Fresh water capacity, reserve feed	137 tons
Designed shaft horsepower	3,000
Estimated steaming radius	7,400 miles

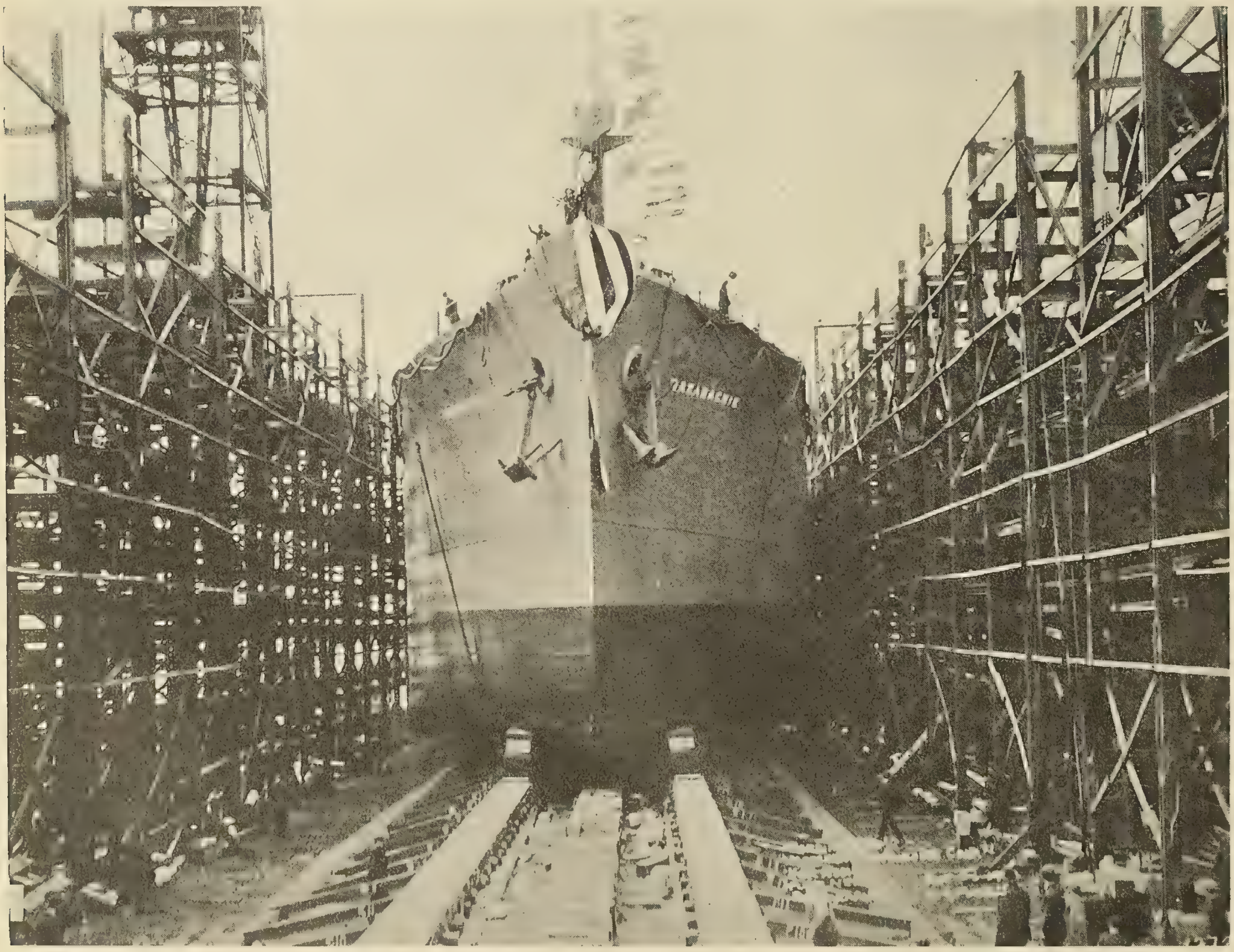


Fig. 2.—Launching of One of the Fabricated Ships at the Harriman, Pa., Yard of the Merchant Shipbuilding Corporation

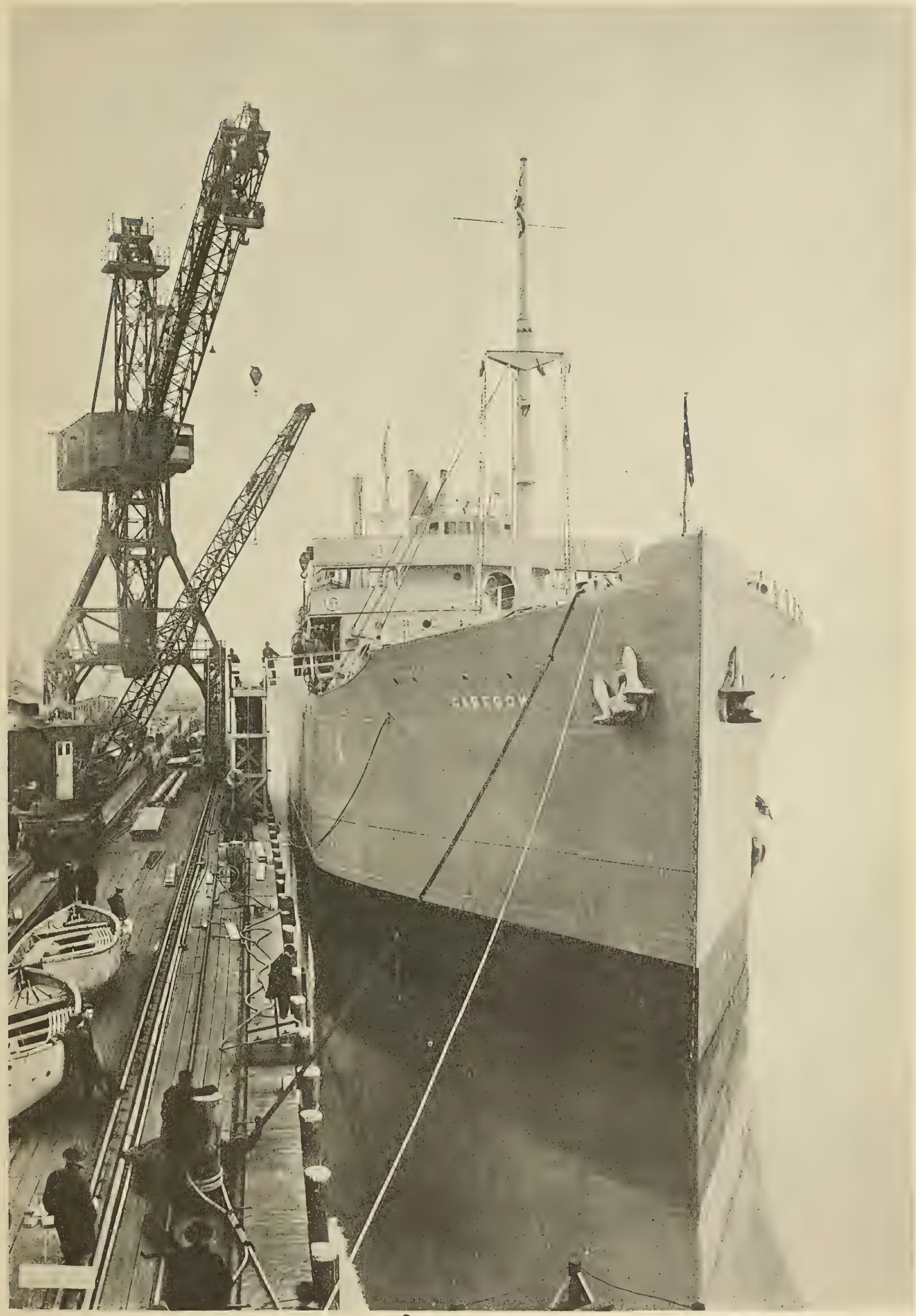


Fig. 3.—Fabricated Ship at Fitting-Out Dock of Merchant Shipbuilding Corporation Receiving Complete Westinghouse Machinery Equipment

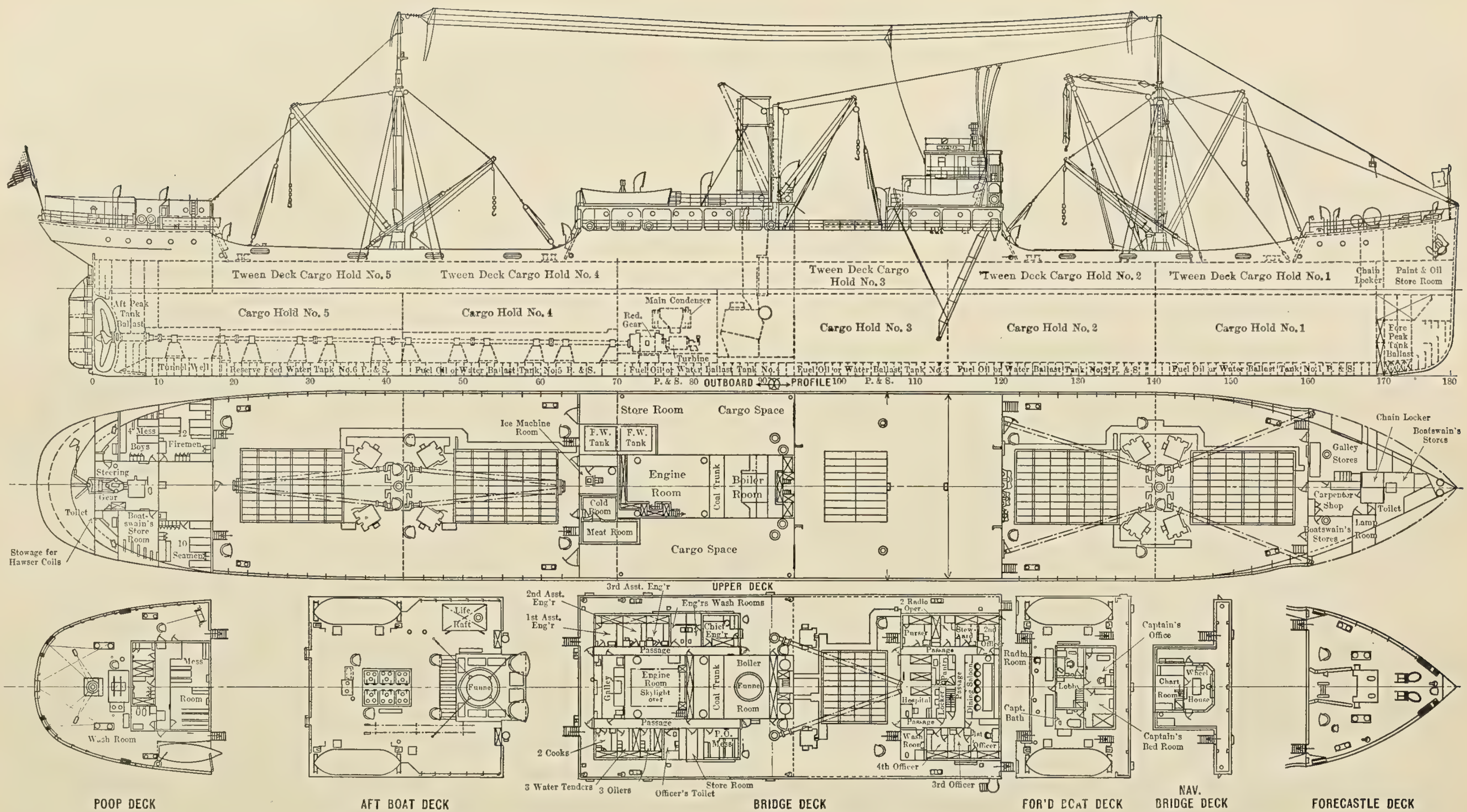


Fig. 4.—General Arrangement Plans of 9,000-Ton Deadweight Fabricated Cargo Vessel Built by the Merchant Shipbuilding Corporation, Harriman, Pa., and Equipped with Westinghouse Propelling and Auxiliary Machinery

These vessels are built under the joint rules and inspection of Lloyd's Register of Shipping and the American Bureau of Shipping and are of the highest classification.

With many years of experience in the building of power equipment, both stationary and marine, the Westinghouse Electric & Manufacturing Company was well able to assume the work of furnishing the complete propelling equipment, which consists of the following units:

Main turbines	3,000 shaft horsepower
Reduction gears	3,360-90 revolutions per minute
Main condenser	4,000 square feet
Auxiliary condenser	800 square feet
Main circulating pump unit	4,000 gallons per minute
Two condensate pump units	6,000 gallons per hour each
Two air ejectors	Size "E"

The Westinghouse Company is also furnishing the complete line shafting, together with the line shaft bearings and sterntube.

The boiler equipment consists of three Babcock and Wilcox watertube boilers of 2,900 square feet of heating surface each, fired with oil, using Schutte and Koerting burners. There is also included a Foster superheater in each boiler with a heating surface of 290 square feet and an induced draft system using a Sturtevant fan.

In addition to the main units there are the following pumps and miscellaneous auxiliaries:

Two boiler feed pumps, National Transit, 12 inches by 8 inches by 24 inches, vertical simplex.
One bilge pump, National Transit, 6 inches by 5¾ inches by 6 inches, vertical duplex.
One fire and bilge pump, National Transit, 10 inches by 8½ inches by 12 inches, vertical duplex.
One ballast pump, National Transit, 10 inches by 12 inches by 12 inches, horizontal duplex.
One fresh water pump, Worthington, 4½ inches by 3¾ inches by 4 inches, horizontal duplex.
One sanitary pump, Worthington, 6 inches by 5¾ inches by 6 inches, horizontal duplex.
Two lubricating oil pumps, Worthington, 7½ inches by 7 inches by 10 inches, vertical duplex.
One lubricating oil cooling water pump, Worthington, 7½ inches by 7 inches by 10 inches, vertical duplex.
Two fuel oil pumps, National Transit, 5¼ inches by 3½ inches by 5 inches, horizontal duplex.
One fuel oil transfer pump, National Transit, 7½ inches by 7½ inches by 10 inches, horizontal duplex.
One evaporator pump, National Transit, 4½ inches by 4 inches by 4 inches, horizontal duplex.
Two 15-kilowatt General Electric generators with reciprocating engines, 8 inches by 6 inches, vertical.
One combined auxiliary air and circulating pump, Dean.
Two Griscom-Russell oil coolers, 300 square feet.
One Schutte and Koerting duplex oil strainer, 4-inch.
One Richardson Phœnix oil filter, No. 75.
One Frick refrigerating machine, 1 ton.
One evaporator, Locomotive Feed Water Heater Company.
One Griscom-Russell distiller.
One feed heater, Locomotive Feed Water Heater Company.

The propeller is four-bladed, cast iron, turning at 90 revolutions per minute, having a diameter of 17 feet, a pitch of 14 feet and a developed area of 90.33 square feet.

The deck machinery and other miscellaneous equipment consists of the following:

One windlass, Welin Marine Equipment Company, 10 inches by 10 inches.
One capstan, Hyde Windlass Company, 8 inches by 8 inches.
Eight winches, American Clay Machinery Company, 9 inches by 9 inches.
Two winches, Lidgerwood, 8¼ inches by 8 inches.
Steering gear, Williamson screw type, American Engineering Company, 9 inches by 9 inches.
Wireless, Lowenstein navy type, 2-kilowatt.
Searchlight, Carlisle & Finch, 8,000 candle-power, 18-inch.

The propelling machinery furnished by the Westinghouse Electric & Manufacturing Company represents the latest development in marine geared turbine equipment, and a description of the various units is as follows:

The turbines are of the Westinghouse combined impulse-reaction, cross-compound type, consisting of a high-pressure and a low-pressure unit, each of which is connected to a first reduction pinion through a flexible shaft and coupling.

Main Turbines

The high-pressure turbine consists of a two-row impulse stage followed by a reaction drum from which the steam exhausts through a cross-connecting pipe into the low-pressure turbine, where the expansion is completed in a second drum of reaction blading. By an arrangement of emergency pipes and valves it is possible to operate either turbine alone under high-pressure steam, exhausting directly into the condenser.

The reversing requirements are taken care of by placing a two-row impulse stage in the exhaust end of each unit, which are compounded in a similar manner to the ahead elements. High-pressure steam is admitted to the astern element of the high-pressure turbine only, from which it exhausts through a cross-connecting pipe into the astern element of the low-pressure turbine.

The astern turbines are capable of developing 60 percent of the full load power ahead when supplied with a steam flow equal to the full power ahead condition.

By an arrangement of emergency pipes and valves similar to that for ahead operation it is possible to operate either the high-pressure or the low-pressure astern element independently, using high-pressure steam and exhausting directly into the condenser.

Full Power Operating Condition

Steam pressure at turbine inlet	185 pounds per square inch gage
Superheat	50 degrees F.
Speed	3,360 revolutions per minute
Normal power	3,000 shaft horsepower
Water rate, exclusive of auxiliaries	11.25 pounds per shaft horsepower per hour
Vacuum, referred to 30-inch barometer	28 inches Hg.
Reversing power	1,800 shaft horsepower

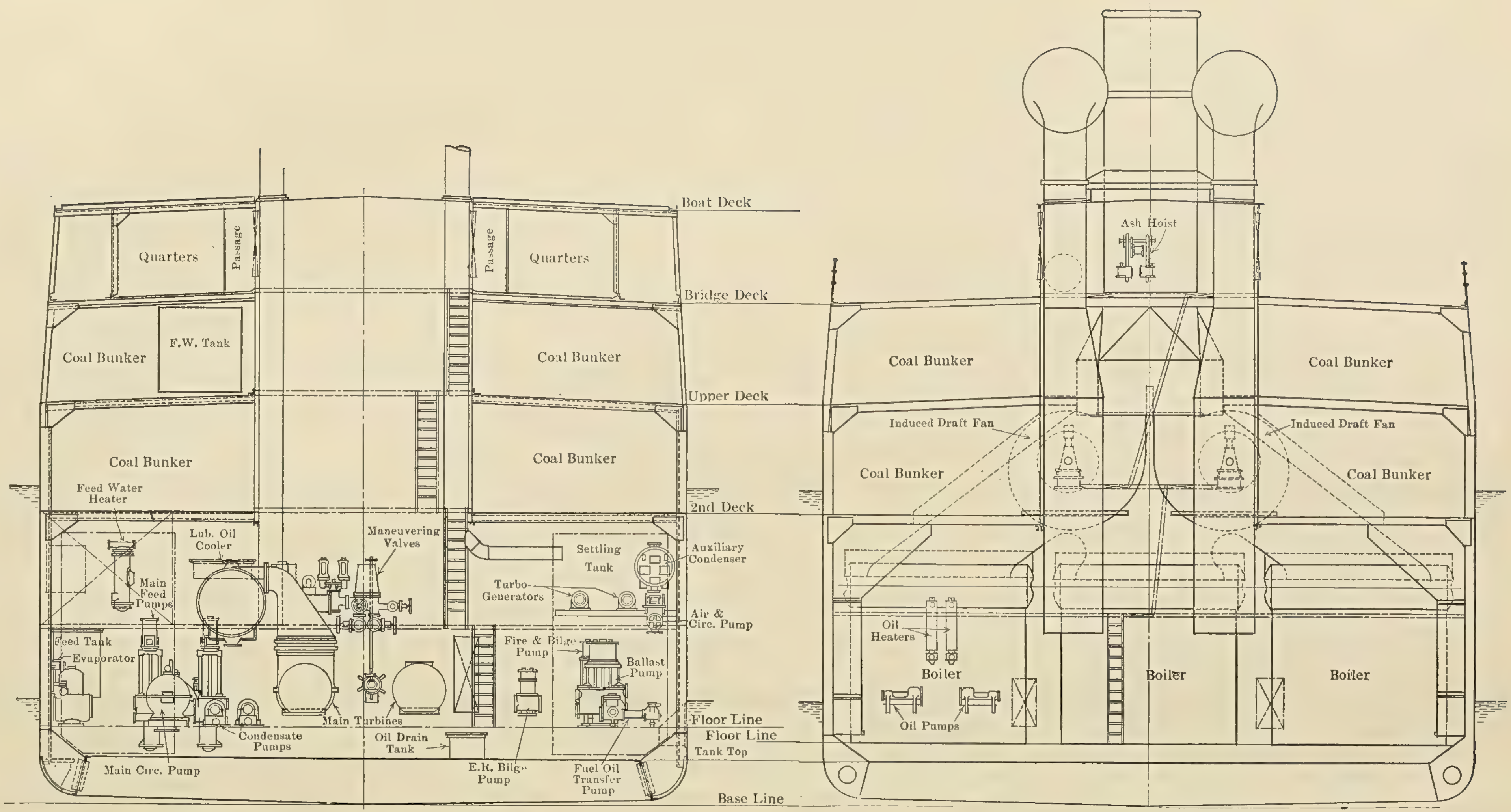
The ahead inlet nozzles are arranged in three groups. The main group contains sufficient area to pass 85 percent of the full load steam flow and two auxiliary groups contain 20 percent of normal steam flow area each. These last two groups can be opened or closed by means of hand valves, and under normal conditions full power will be obtained with one hand valve open, there being a slight margin allowed, so that the inlet pressure need not be kept at the maximum all the time. By opening the second hand valve the steam flow may be increased to the extent of 25 percent above that normally required for full load, thus permitting full power to be realized at any time should the pressure, vacuum or both fall a corresponding amount below normal operating conditions.

The astern nozzles are not arranged for group control because economy when operating astern is of little importance.

The turbine cylinders are made of close-grained cast iron and consist of base and cover joined by horizontal flanges. The stationary reaction blading is mounted in grooves on the inside of the cylinders.

The high-pressure inlet nozzles—both ahead and astern—are of the diverging type, made of cast bronze, hand-finished and are mounted in the steel nozzle chambers, which bolt onto the inside of the cylinders. These nozzle chambers also form the base on which the stationary impulse blades are mounted, thus insuring perfect alinement between the nozzles and the stationary blades at all times.

At the exhaust end of each turbine the main bearing



Section at Frame No. 74, Looking Forward

Section at Frame No. 93, Looking Aft

Fig. 5.—Sections Through Engine and Boiler Rooms

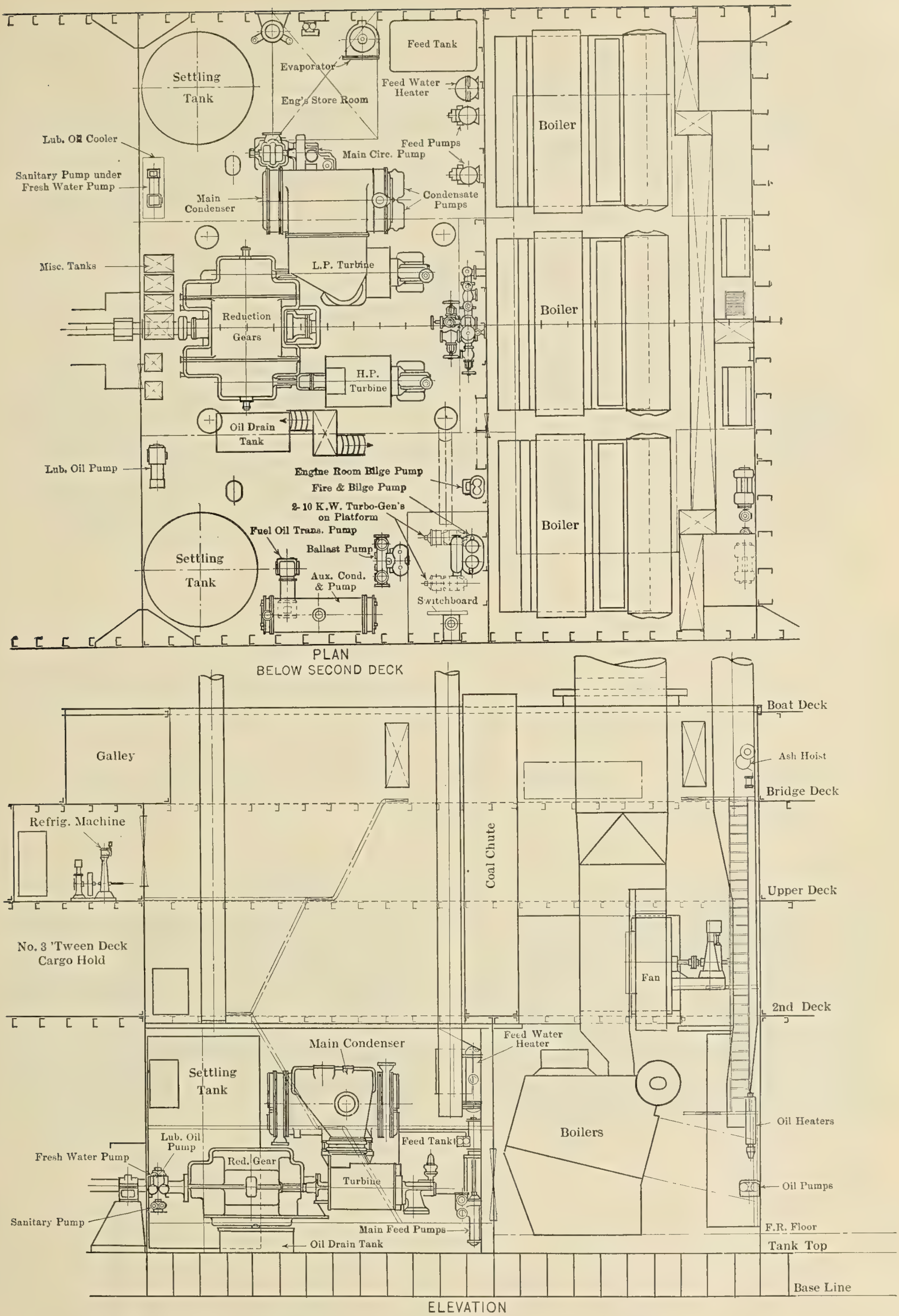


Fig. 6.—Plan and Longitudinal Section Through Machinery Space

pedestal is cast as an integral part of the base, while at the inlet end the pedestal is a separate casting bolted on. This forward pedestal carries not only the main bearing, but also the thrust bearing and the governor.

The after bearing pedestal is rigidly bolted down to the seating (several of the bolts being fitted), but the forward pedestal is provided with a sliding foot supported by a steel sole plate with guides, which permit of horizontal longitudinal movement only. Thus, the turbines are free to expand or contract endwise without setting up any stresses tending to warp the cylinders.

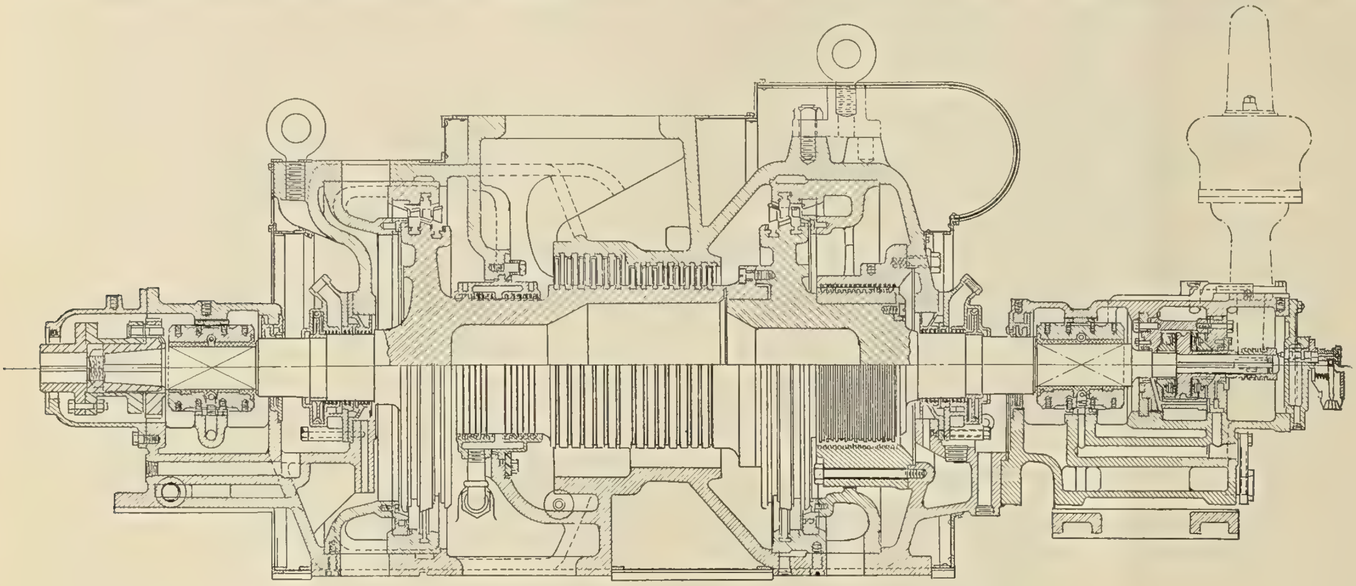


Fig. 7.—Longitudinal Section Through High-Pressure Turbine

The main bearings are of the self-alining type consisting of cast iron shells in halves, lined with genuine babbitt metal and provided with pads and adjusting liners on the top, bottom and sides. Oil is fed to the bearings under pressure, being admitted through a passage drilled in the bottom pad and liners, and conveyed to the top of the bearing by means of a tube which is cast in the babbitt lining. The bearing housings and covers are fitted with oil guard rings, which prevent any leakage of oil along the shaft and at the same time exclude dust.

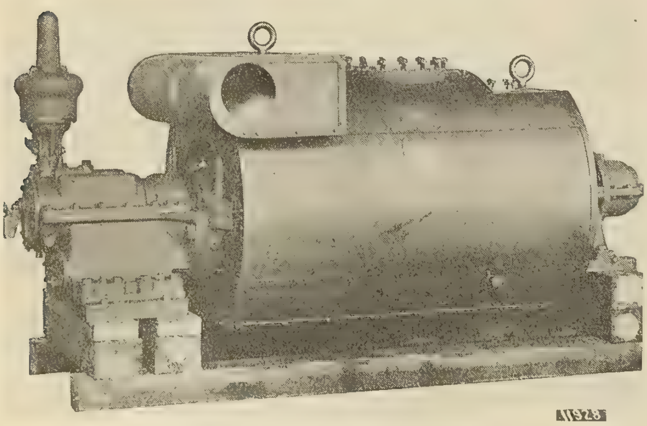


Fig. 8.—High-Pressure Turbine

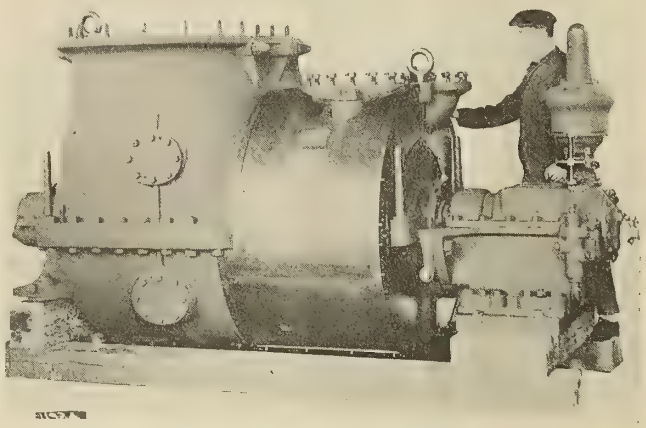


Fig. 9.—Low-Pressure Turbine

The turbine rotors are of the hollow drum construction, being made of a high grade of open hearth steel. The high-pressure turbine rotor is built up of two parts securely bolted together, while the low-pressure turbine rotor consists of three parts. However, in both cases the impulse wheels are included as integral parts of the rotor elements.

By this drum type of construction a very rigid spindle is obtained in which the deflections are so small that the first critical speed is far above the normal running condition.

The impulse blades are very rugged in construction, being machined out of nickel steel sections and secured in the rotor by a tongue and groove construction with side wedges to prevent vibration. The shrouding is formed as an integral part of the blades and additional stiffness is obtained by a circumferential binding strip which is driven into a dovetail groove and brazed.

The reaction blades are made of phosphor bronze and are secured in the dovetail grooves by a positive mechanical interlock between the blades, the packing pieces and the sides of the groove.

In the bottom of the main groove there is cut a supplementary groove into which extends an upset foot on the blade. This upsetting operation increases the thickness of the whole lower portion of the blades, adding to their area about 40 percent, tapering off to the standard section some distance above the surface of the blade-carrying element. This thickening is not clearly shown in Fig. 18. Dovetail packing pieces are inserted between the blades, and the forged foot of each blade coming beneath the

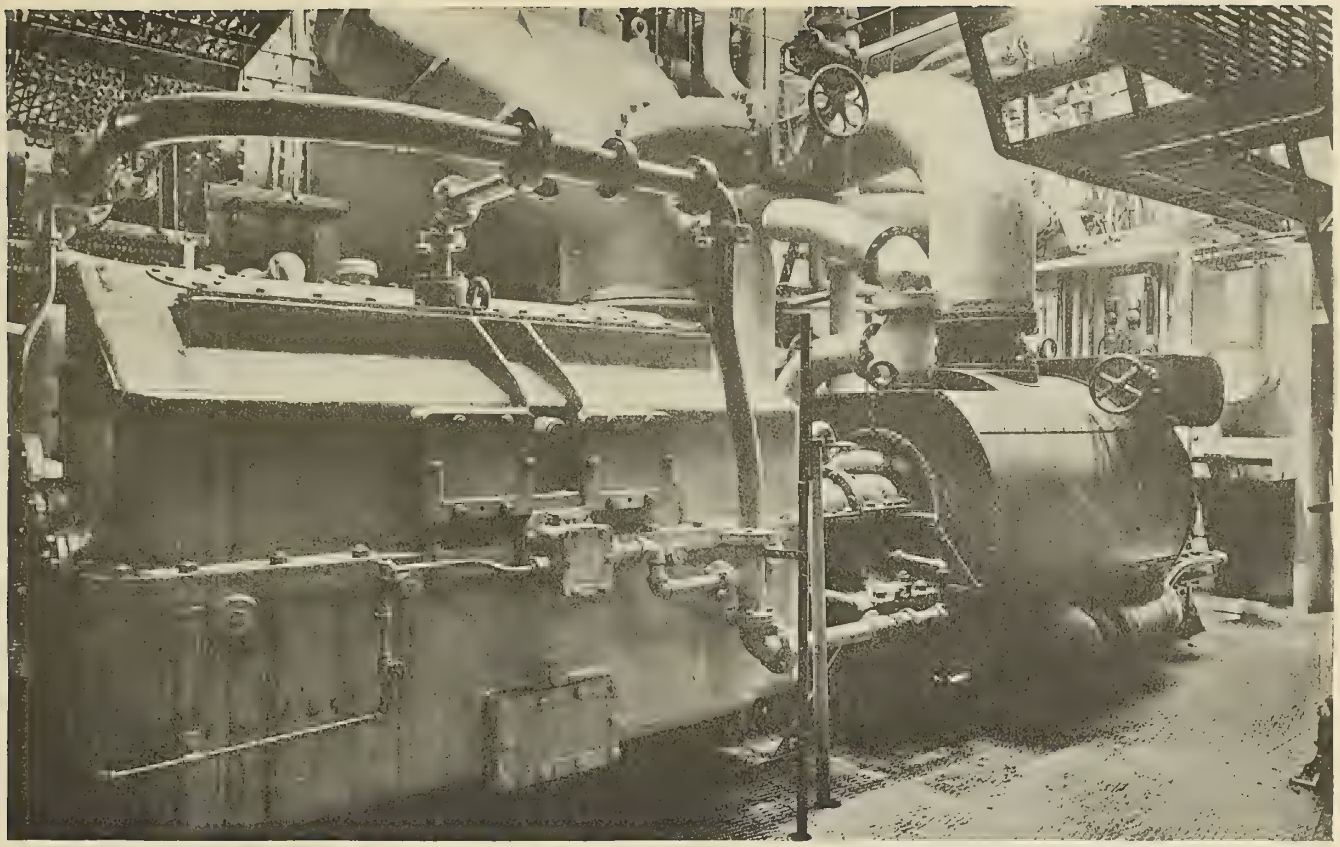


Fig. 10.—View of Engine Room Looking Forward from Starboard Side, Showing Reduction Gear and High-Pressure Turbine

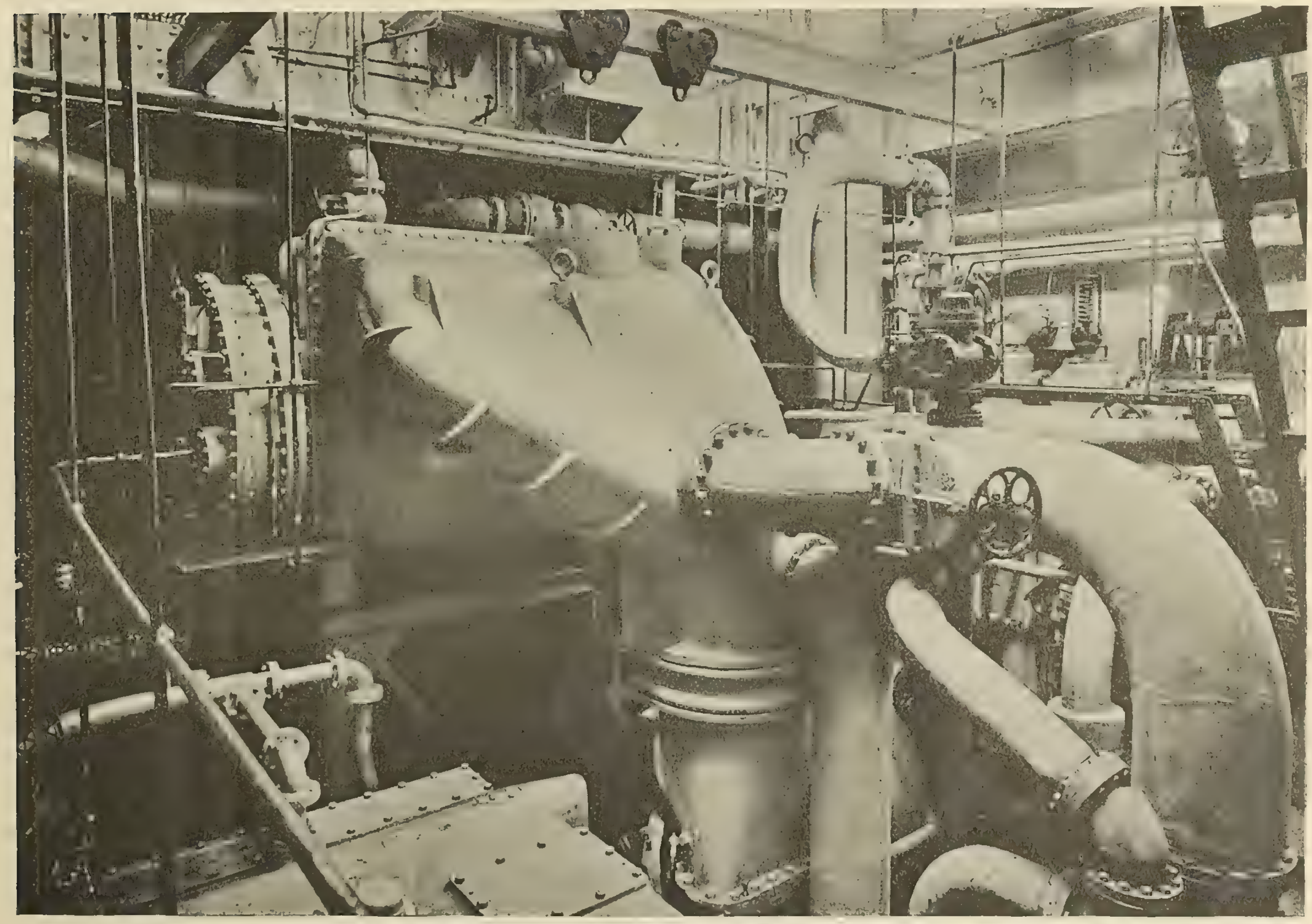


Fig. 11.—View of Engine Room from Lower Grating, Showing Low-Pressure Turbine, Main Condenser and Exhaust Trunk

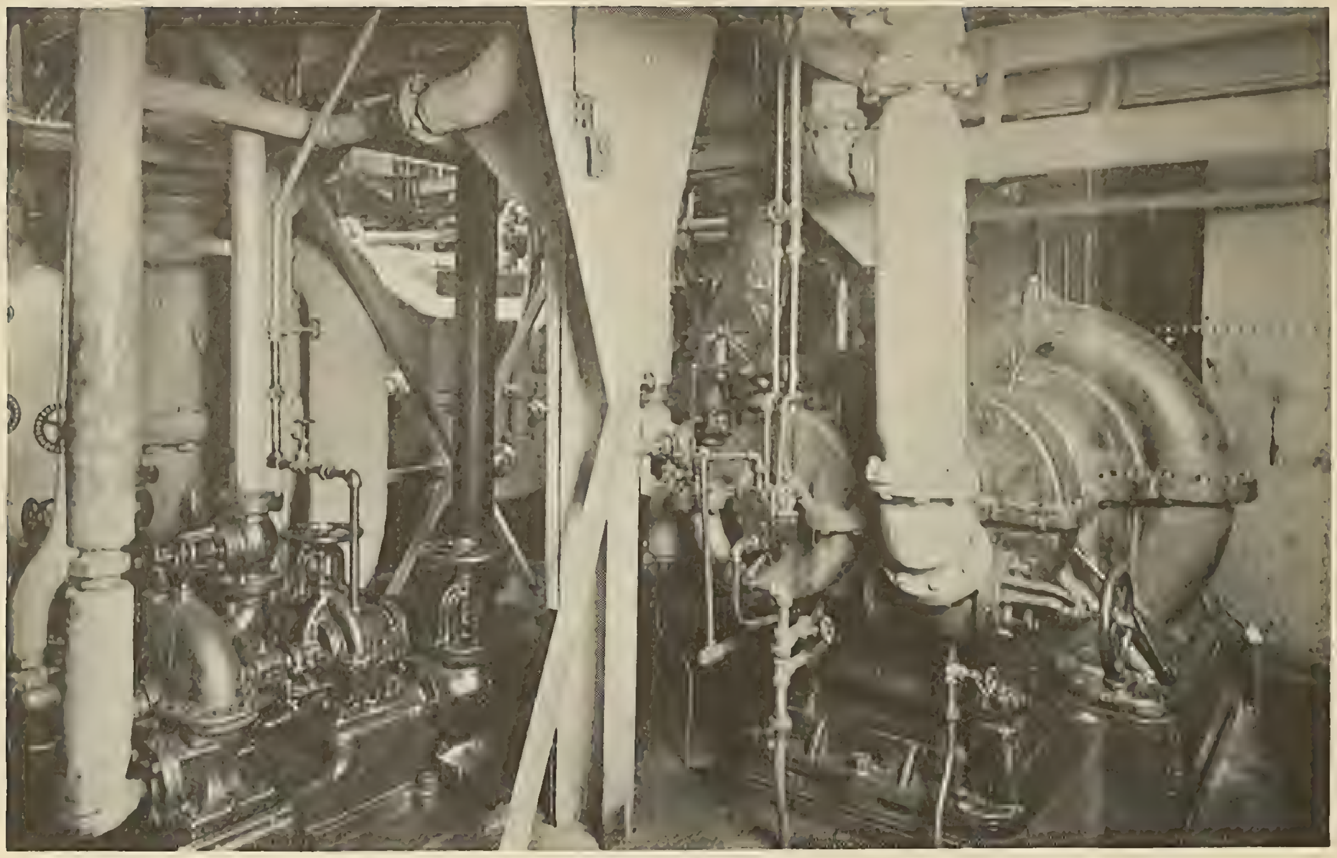


Fig. 12.—View of Engine Room from Port Side Looking Aft, Showing Condensate Pumps and Main Circulating Unit

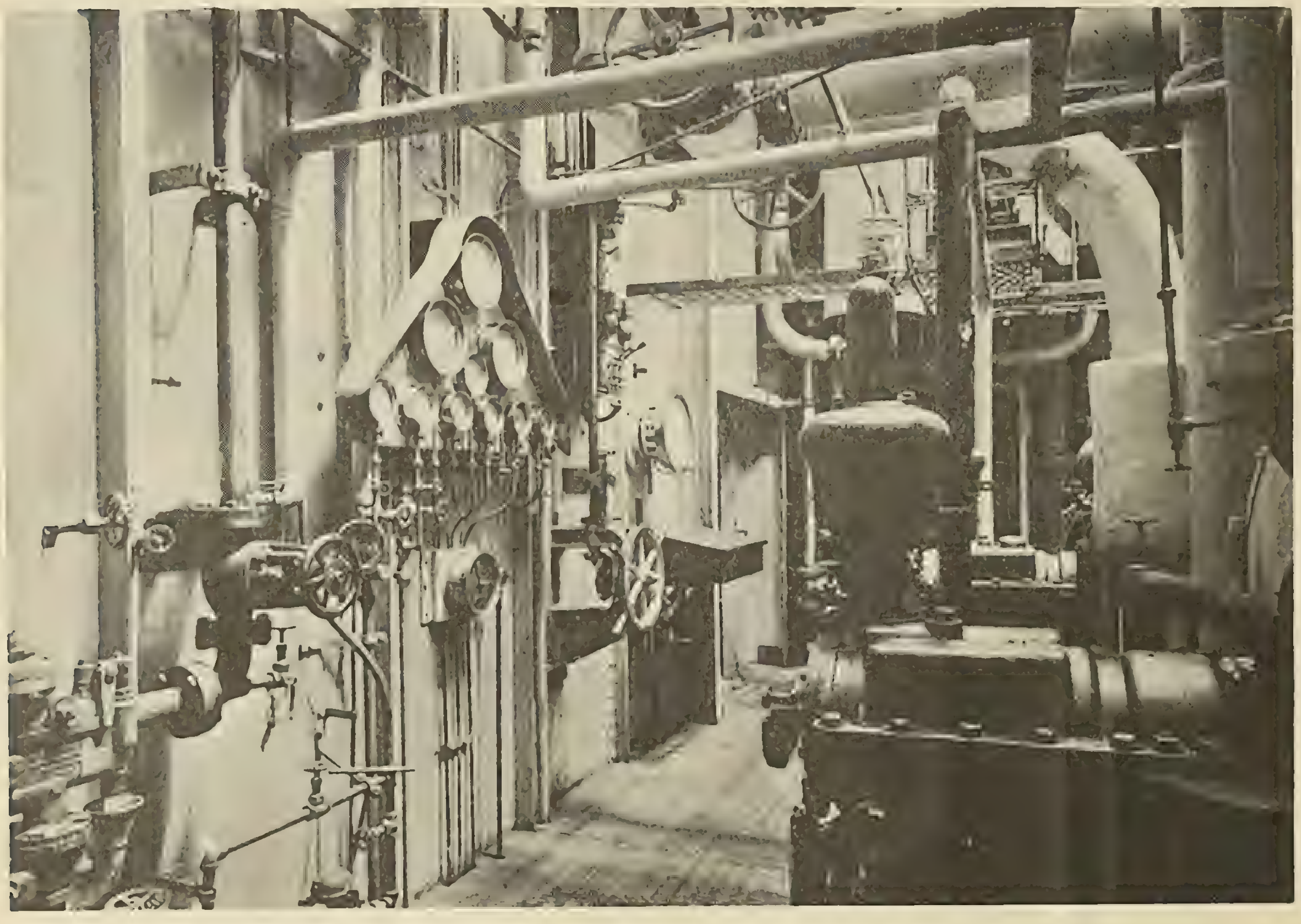


Fig. 13.—View Showing Operating Platform at Forward End of Engine Room

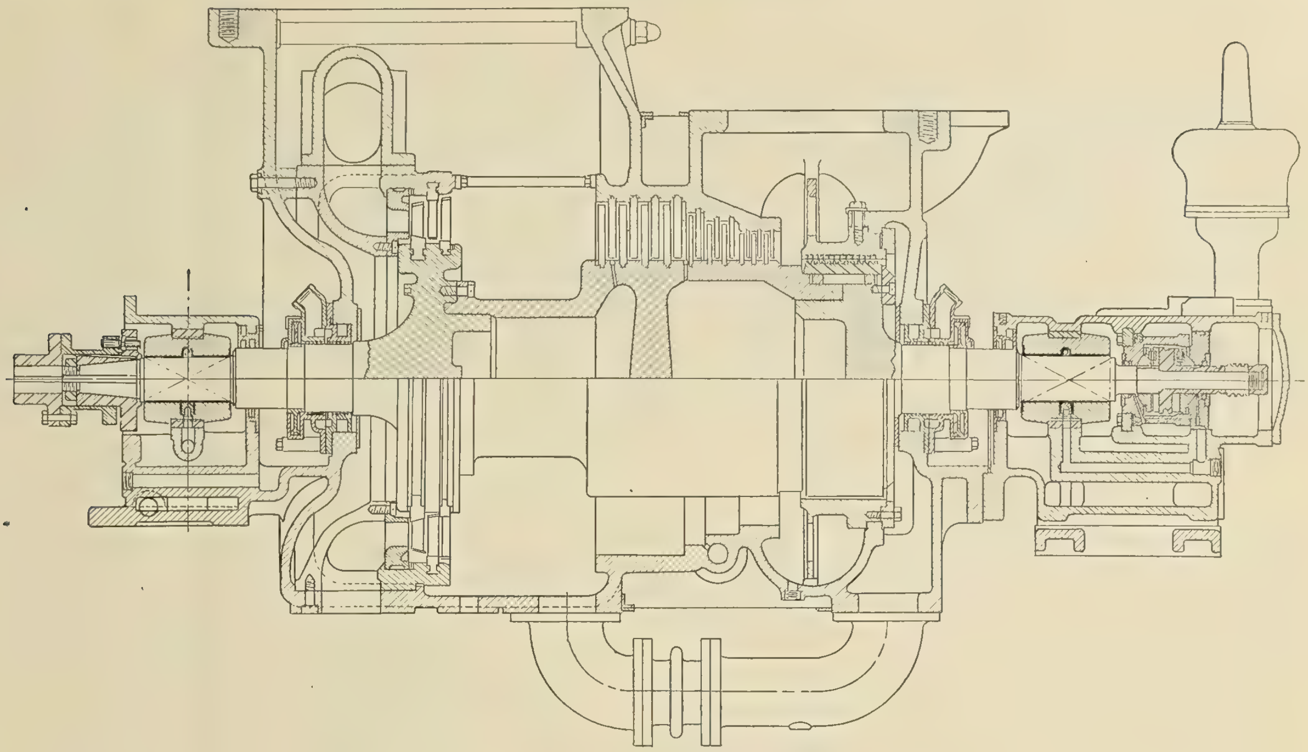


Fig. 14.—Longitudinal Section Through Low-Pressure Turbine

packing pieces provides an interlocking system with which no calking is necessary, making it possible to replace blades an indefinite number of times without mutilation of the blade-carrying member.

Lashing wires in sufficient number are provided for bracing the upper ends of the blades, the number of these lashings depending on the length of the blades.

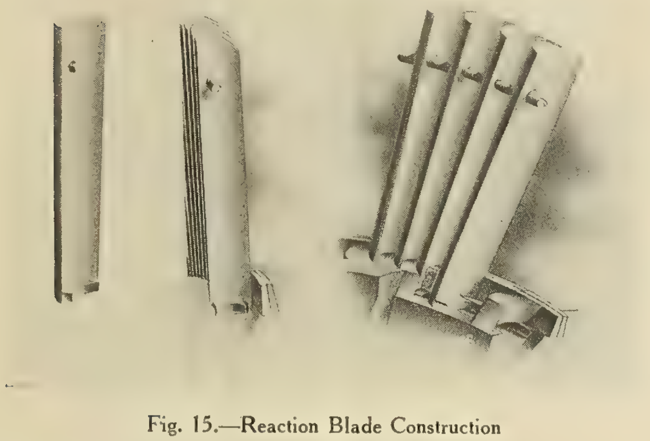


Fig. 15.—Reaction Blade Construction

As in all turbines of this type, when in operation there is an axial thrust due to the steam pressure, tending to move the spindle endwise. This is partly counterbalanced by means of a balance piston or dummy of the radial contact type placed at the forward end of each turbine and the remainder of the end thrust is absorbed by a Kingsbury type thrust bearing. By this arrangement a short dummy of small diameter is obtained, which feature adds considerably to the reliability and prolonged economy of the machine. The dummy piston is formed by a forged steel ring shrunk and keyed to the turbine spindle. On this ring are turned square ridges alternately high and low. In the cylinder dummy ring, which is a casting bolted to the cylinder, are fitted narrow aluminum strips which are turned to correspond with the ridges on the dummy piston. The inner edges of the aluminum strips are approximately 1/32-inch wide and clear the ridges on the dummy piston by only a few thousandths of an inch, thereby reducing the steam leakage to a very small amount. However, since the close clearance is in a radial direction only, the dummy imposes no limits on the end movement of the

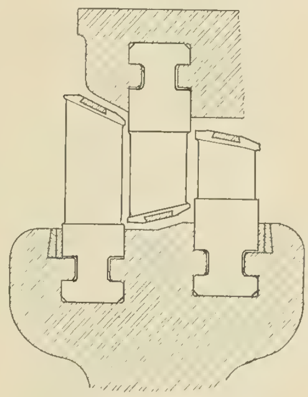


Fig. 16.—Impulse Blade Construction

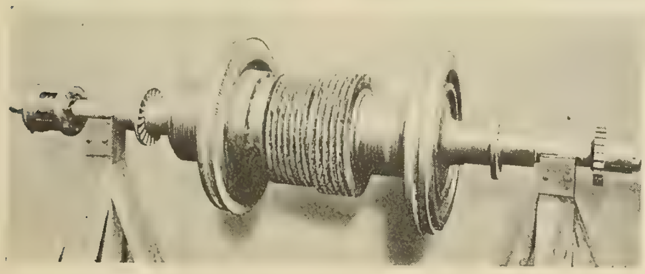


Fig. 17.—High-Pressure Turbine Rotor

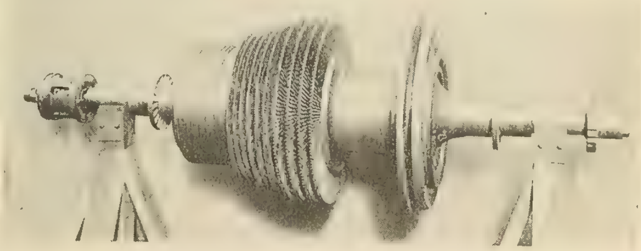


Fig. 18.—Low-Pressure Turbine Rotor

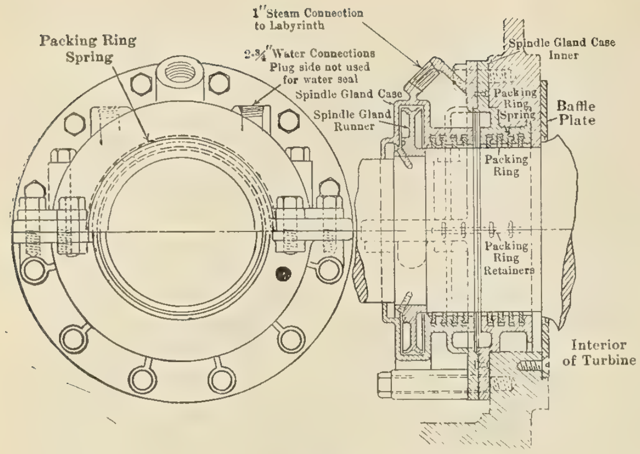


Fig. 19.—Spindle Gland

spindle. Whatever steam leaks past this packing is carried to the exhaust end of the turbine through a liberal-sized pipe known as the equilibrium pipe, thus preventing any back pressure from building up on the outside end of the dummy.

The glands for preventing leakage where the spindle passes through the casing at each end are of the combined steam and water sealed type. The water gland is designed effectively to seal at all speeds from and above half speed, and below that the steam seal is used.

The water gland consists of a runner similar to the runner of a centrifugal pump which revolves in the gland casing. Fresh water is supplied from the condensate gravity tank and a solid annulus of water is maintained at the outer edge of the runner, thereby producing an hermetic seal which entirely precludes leakage.

The steam seals on the low-pressure turbine consist of two sets of aluminum packing rings with an opening between, to which steam is admitted at a reduced pressure. On the high-pressure turbine the steam seals are somewhat different, because they have to pack against a pressure greater than atmosphere. In this case there are three sets of packing strips. Between the two inner sets is a leak-off chamber, which is piped to a suitable connection on the low-pressure turbine, serving to dispose of the leakage steam, and at the same time utilize it to good advantage in the low-pressure blading. Reduced pressure sealing steam is supplied to the opening between the two outer sets of rings the same as in the low-pressure glands.

The steam and water used for sealing the turbine glands may be controlled by hand-operated valves or by the gland control valve which automatically regulates whether the steam or the water shall be in use according to the speed of the turbine. This is accomplished by incorporating in the governor relay valve an extra set of ports which operate the gland control valve in a similar manner that the main ports operate the main governor valve. The governor is provided with two springs and its travel is divided into two zones. The inner travel of the governor weights is opposed by the light spring only, the governor weights being able to compress this spring at the speed at which the gland should change over from the steam seal to water seal. The heavy spring comes into engagement at this speed, but the governor weights are unable to compress the two springs together until the turbine reaches the speed corresponding to which the governor should regulate the steam supply to the turbine (approximately 8 to 10 percent overspeed).

Motion of the governor through the first part of its travel will, by means of the relay which it operates, either relieve or impose pressure in the chamber "x" of the gland

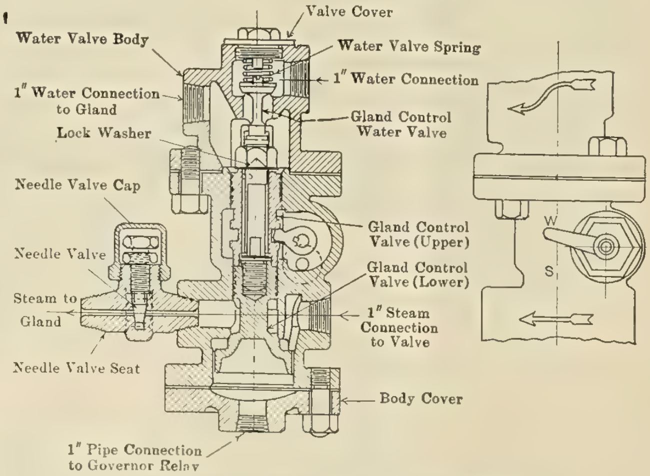


Fig. 21.—Automatic Gland Control Valve

control valve, causing motion of the valve to either change from steam to water or vice versa, according to whether the turbine speed is accelerating or retarding.

These spindle glands can be removed for inspection or repair without disturbing the turbine casing.

To separate the ahead and astern chambers of the high-pressure turbine, which are always at different pressures, there is interposed a diaphragm cast as an integral part of the casing. The packing between the diaphragm and the rotor is of the labyrinth type, very similar to the steam glands at each end of the turbine, with the exception that between each two packing strips a slight ridge is turned on the rotor which further impedes the flow of the steam tending to leak through. The packing is divided into two groups of strips with an annular space between, from which a pipe leads to a suitable stage in the low-pressure turbine. Any leak past the first set of labyrinth rings is thus taken care of and utilized to advantage in the low-pressure blading.

The Kingsbury thrust

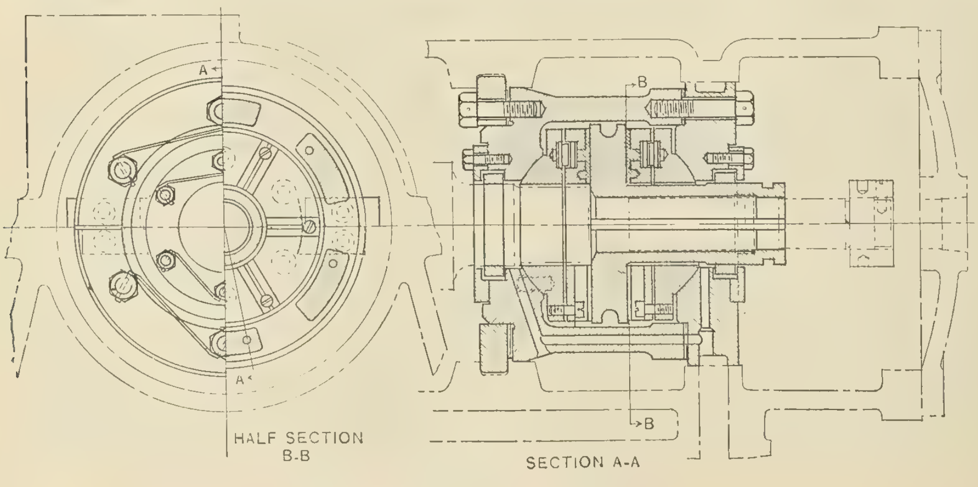


Fig. 20.—Turbine Thrust Bearing

bearing mounted on the forward end of each turbine consists of steel collar keyed to the shaft with a set of segment-shaped shoes on each side to take the thrust in either ahead or astern direction. The shoes are faced with genuine babbitt metal, and in the back of each is fitted a spherically-faced hardened steel button. These buttons

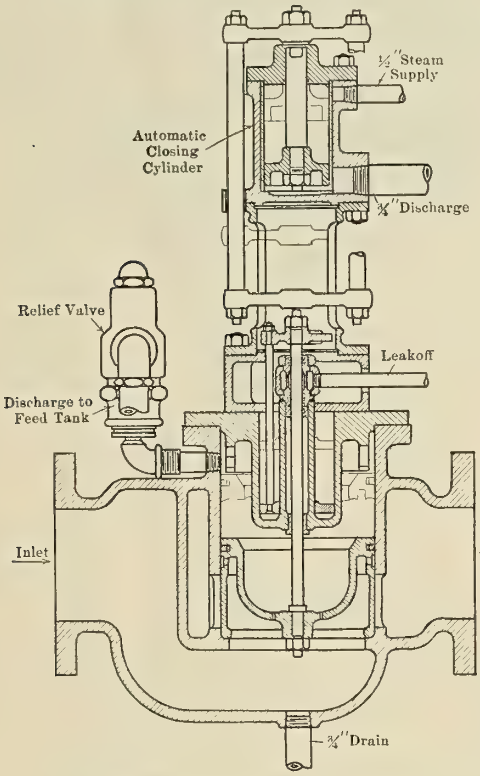


Fig. 22.—Constant Pressure Valve

rest on flat, hardened steel pieces inserted in a spherically-seated base ring, which automatically centers itself, so as to distribute the load equally over all the thrust shoes.

The base rings are supported in an inner skeleton housing which is held from moving endwise by a steel adjusting ring which fits into a groove in the outer housing. Adjustment of the longitudinal blade clearances is made by moving the inner thrust housing as a whole one way or the other, which is effected by changing the total thickness of the liners between the inner housing and the adjusting ring.

The thrust bearing is lubricated by oil passing through drilled passages into the periphery of the shaft on each side of the collar, and, in order to keep the entire housing filled with oil at all times, the inlet is placed at the bottom and the outlet on top, the outgoing oil passing to the governor worm chamber and thence to the pedestal oil drain space.

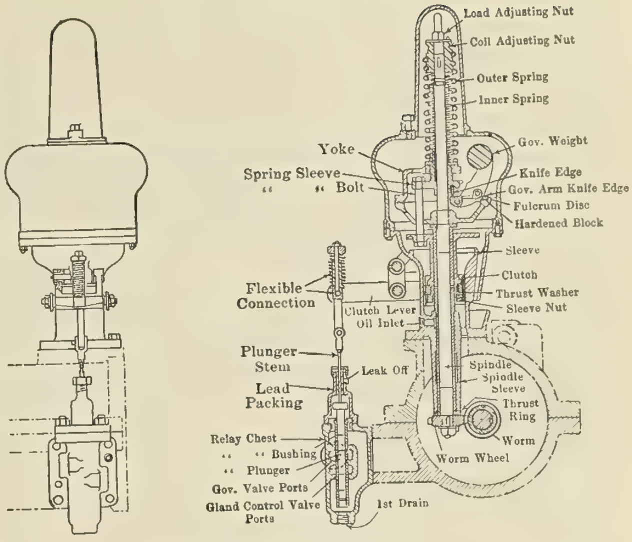


Fig. 23.—Turbine Governor

The fore and aft position of the turbine spindle may be checked at any time by means of the spindle indicator which is mounted on the forward end of each turbine. It consists of a pin extending through the end cover plate and rubbing against the retaining nut on the end of the shaft. The movement of this pin is multiplied by means of a pointer, so that the travel indicated is about five times the actual movement of the spindle. When not in use the indicator pin is pulled back out of contact with the spindle nut so as to prevent wear. However, it should be mentioned that the contact surface is so well lubricated by the oil inside the housing that frequent use of the indicator does not result in any appreciable wear.

All parts of the turbines and piping in which water is likely to collect are connected by drain pipes to a small steam ejector which delivers this water into the condenser. This ejector is necessary on account of the condenser being located at a higher level than the turbine.

To guard against the possibility of the turbines over-

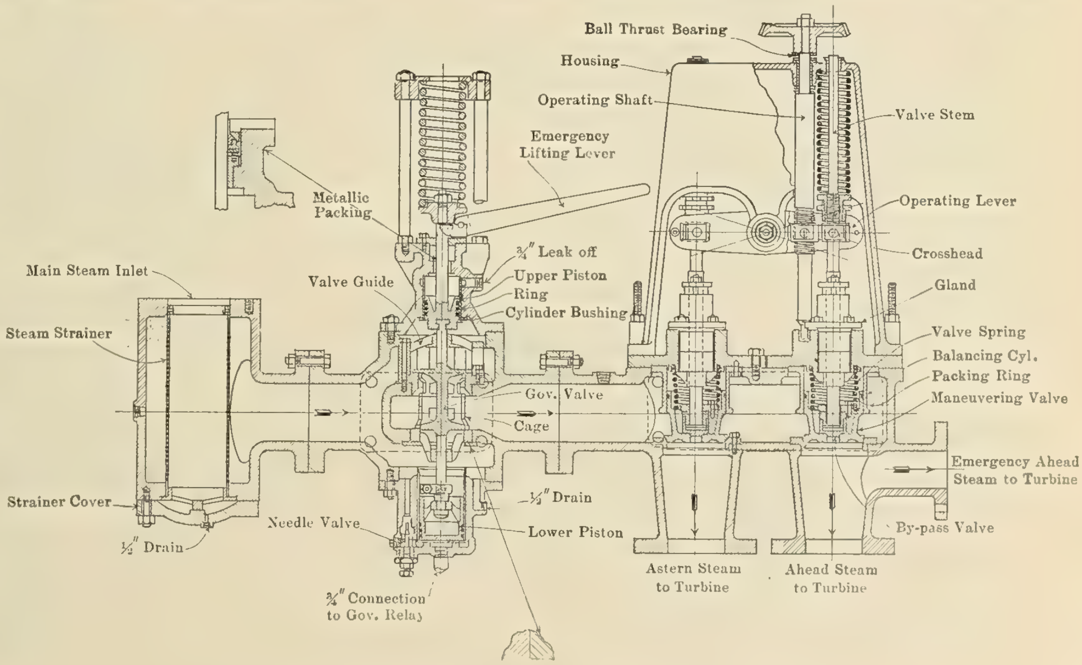


Fig. 24.—Maneuvering Valve, Governor Valve and Strainer

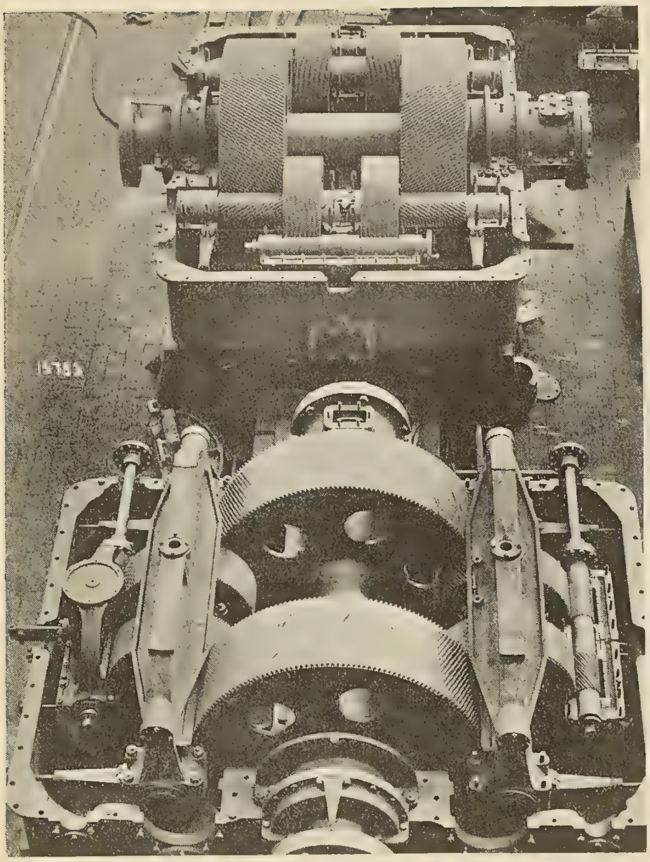


Fig. 25.—Reduction Gears with Cover Removed

speeding, due to the breakage of a shaft or *"racing"* in rough weather, there is included on each machine an emergency overspeed governor, by means of which the turbine speeds are always held within safe limits, although under no conditions are they shut down entirely.

The arrangement consists of a vertical spindle mounted on the forward end of each turbine, driven by a worm

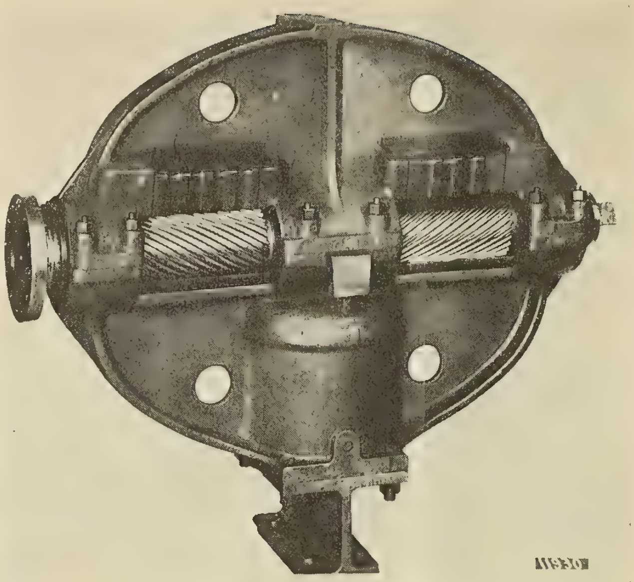


Fig. 27.—First Reduction Pinion Frame, Showing Flexible I-Beam Support

wheel from the main shaft at a speed of about one quarter of that of the main shaft. At the top of this spindle is mounted a fly ball governor, the motion of which is transmitted through a system of levers to a small steam relay piston valve, which in turn regulates the steam pressure in the operating cylinder of the main governor valve.

The governor valve is located in the main steam line on the boiler side of the maneuvering valve between that and the strainer. It consists of a double disk balanced poppet valve with operating pistons at the top and bottom of the valve stem, and an external spring on top, the function of which is to prevent the valve from hunting rapidly.

The admission of steam to the ahead and astern turbines is controlled by two balanced throttle valves, both of which are contained in one body and operated by the same hand wheel. Turning the wheel in one direction

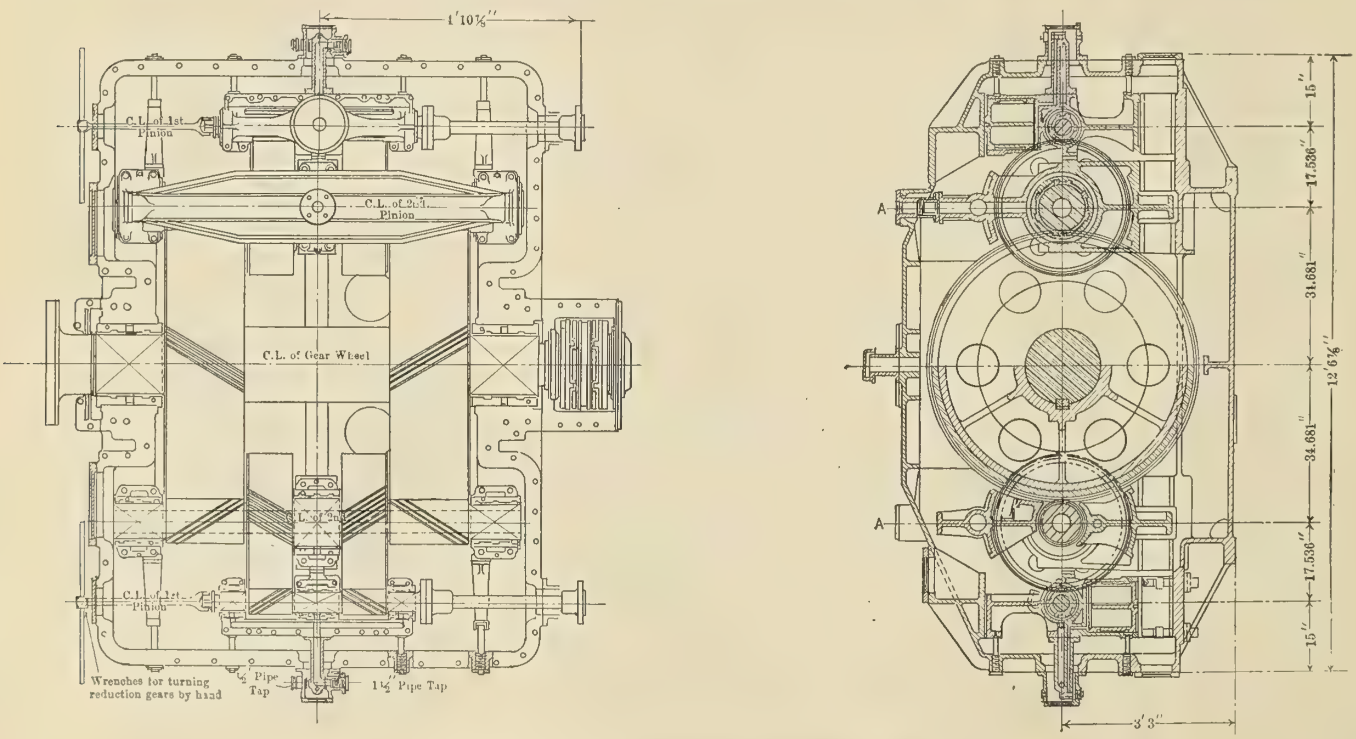


Fig. 26.—General Arrangement of Reduction Gears

admits steam to the ahead nozzles, and in the other direction to the astern nozzles, it being impossible to open both valves at the same time. As the valves are single-seated (balanced by auxiliary piston), absolute tightness can be readily maintained.

A perforated sheet steel cylindrical strainer in a cast steel shell is fitted in the main steam line between the boilers and the turbine valves to protect the valves and turbines from the admission of any foreign substances.

In order to increase the overall economy of the complete installation, the exhaust steam from the auxiliary apparatus, having a pressure somewhat above atmosphere, can be used to advantage in the low-pressure turbine, and a suitable connection on the cross-over receiver pipe is provided for this purpose. A constant pressure valve is interposed, which automatically admits to the turbine any excess of auxiliary exhaust steam not used in the feed heater, and thus keeps the pressure in the auxiliary exhaust header approximately constant.

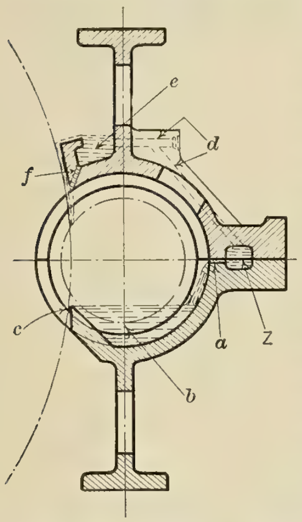


Fig. 28.—Section Through Pinion Frame, Showing Method of Lubrication

The main high-pressure steam piping is of steel and the cross-connecting piping between the turbines is of cast iron. Likewise the main exhaust trunk from the low-pressure turbine to the condenser is of cast iron. Between the exhaust trunk and the low-pressure turbine, and also in the cross-connecting piping, are located copper expansion joints, which prevent any external strains from being transmitted to the turbine casings.

The turbines are connected to the high-speed pinions by means of flexible shafts and pin couplings, which allow sufficient movement of the pinions to insure uniform distribution of the tooth pressures.

The pin type coupling consists of two coupling sleeves which are pressed and keyed onto the turbine spindle and pinion driving shaft respectively. Bolted to the coupling sleeve of the pinion and extending over and centering on the coupling sleeve of the turbine spindle is the coupling head. On the turbine end of this head are mounted twelve pins, which engage corresponding bronze bushed holes in the coupling head on the turbine spindle. Clearance is provided at each end of these pins and also in the bronze bushed holes, so that the pinion is perfectly free to slide axially without imposing stress on either turbine or gears. The bronze bushings are lubricated by oil, which spills out of the bearing and falls into a centrifugal lubricator formed in the coupling head. Holes are drilled

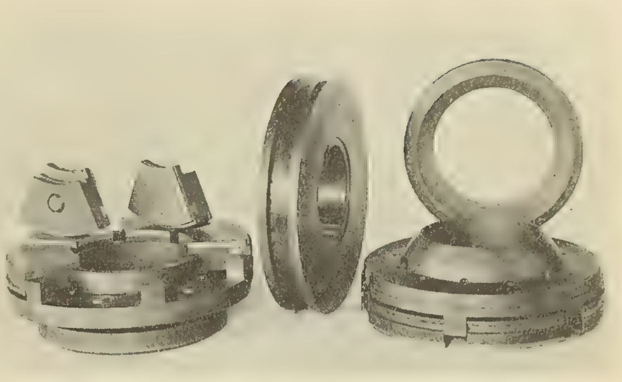


Fig. 29.—Parts of Kingsbury Propeller Thrust Bearing

from this lubricator to each bronze bushing. In a similar manner the sliding fit between the coupling head and the coupling sleeve at the turbine end is lubricated.

Reduction Gear

The double reduction gear is of the Westinghouse flexible frame type, the pinions and gears being double helical with standard involute teeth. Each pinion is carried on three bearings mounted in a frame, which is made rigid enough to maintain the three bearings in alinement. This frame is supported at the center by an I-beam placed at right angles to the axis of pinion, and the flexing of the vertical web of the I-beam allows the whole frame to rotate a slight amount in a vertical plane. This automatically maintains the alinement of the pinion and gear, producing a uniform distribution of tooth pressure over the entire length of the tooth face, even though the gear case be distorted due to weaving of the ship's structure.

The ends of the pinion frames are held in correct position with reference to the gear axis by horizontal struts between the frame and the housing.

The pinions are made of forged steel, heat treated, and

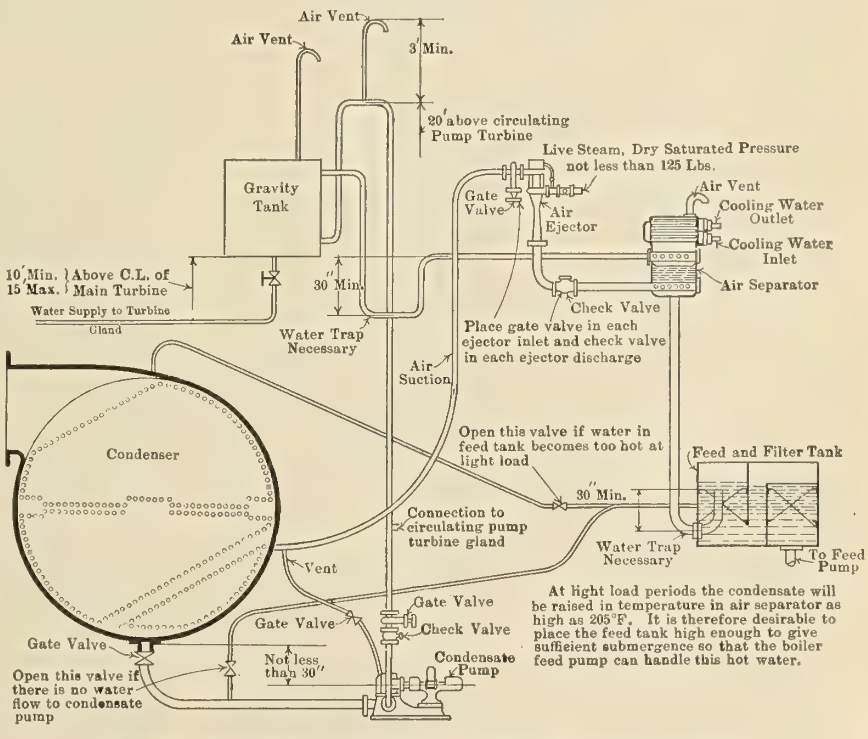


Fig. 30.—Diagram of Westinghouse LeBlanc Condensing Equipment

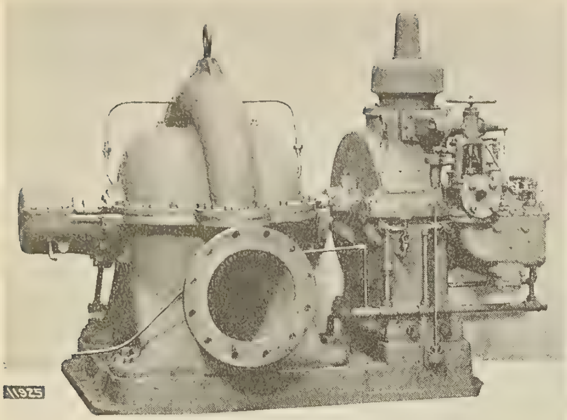


Fig. 31.—Main Circulating Pump Unit

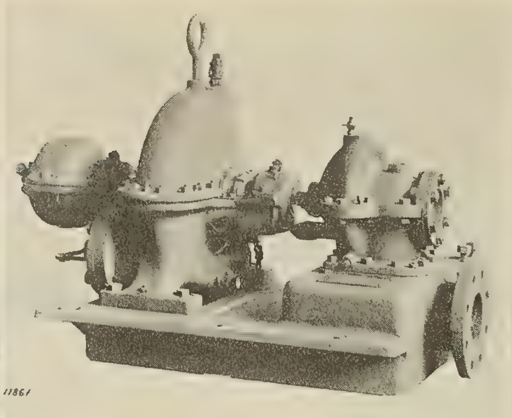


Fig. 32.—Condensate Pump Unit

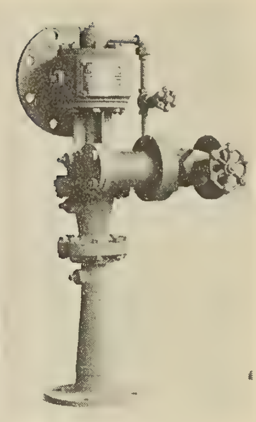


Fig. 33.—Air Ejector

the gear wheels are built up with heavy cast iron centers and rolled steel rims. The high-speed gear wheels are mounted on the low-speed pinion shaft. The second reduction gear wheels are mounted on a heavy forged steel shaft, which couples directly to the propeller shafting.

All bearings are made up of a heavy cast iron shell lined with genuine Babbitt metal. The bearings are split on the horizontal centerline and oil is admitted through a machined passage in the joint.

The method of lubricating the gear teeth is shown in Fig. 28. The frame is designed to have the pinion dipping in oil at the bottom, the oil pan *b* being supplied with oil through holes *a* drilled at the joint of the frame into the main oil supply passage *z*. With the pinion revolving in a clockwise direction looking at the figure, the oil is swept

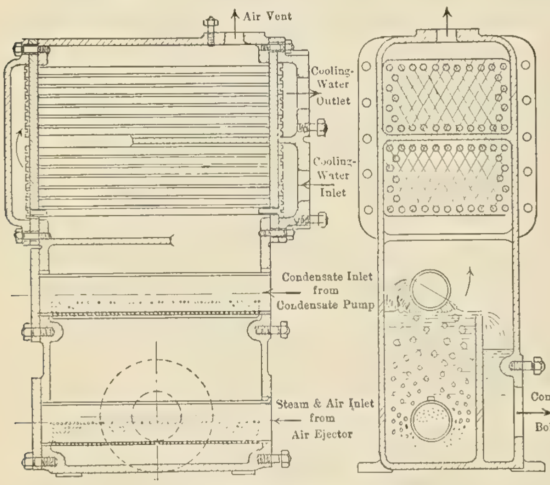


Fig. 34.—Air Separator

from the lip *c* directly into the tooth mesh. Running in the opposite direction oil is supplied from a trough *c*, which is supplied through passage *d*. Holes are drilled in the bottom of this trough for proper distribution of the oil.

With this system of lubrication no oil pipes are required inside the gear case. All oil passages are large, precluding the stoppage of oil. The only small holes through which the oil has to pass are at *f*, and if these become clogged the oil merely overflows the trough and drops between the teeth.

In each high-speed pinion frame is incorporated a hydraulic dynamometer. To measure the horsepower being transmitted, the tooth pressure is balanced by oil pressure in the dynamometer cylinder, and, knowing the oil pressure and area of the piston, together with the diameter and revolutions per minute of the pinion, the horsepower can be determined.

Propeller Thrust Bearing

The propeller thrust bearing is of the Kingsbury segmental type, mounted on the main gear shaft at the forward end of the gear. It is contained in a housing which is solidly fastened to the main gear housing.

The thrust block is shown in the center of Fig. 29, consisting of a steel collar keyed to the gear shaft and held in position by a nut. This collar rotates between two sets of Babbitt-faced thrust shoes. These shoes are fitted at the back with a hardened steel button, each of which rests on a hardened steel piece in the spherically seated base ring. One base ring takes the thrust when going ahead; the other when going astern.

The bearing is always flooded with oil in circulation, this being an essential feature for its satisfactory performance.

Condenser Equipment

The main condenser is of the latest Westinghouse type, designed for producing high vacuum. It is constructed with a cylindrical cast iron shell, Muntz metal tube plates and Admiralty metal tubes. The cooling water makes two passes.

The cooling water is supplied by a centrifugal, geared, turbine-driven pump having a normal capacity of 4,000 gallons per minute. The turbine is designed to develop about 52 horsepower and operates with a steam pressure of 175 pounds per square inch gage, and a back pressure of 10 pounds per square inch gage. It consists of a single high-speed impulse wheel, with a reversing chamber, by means of which the steam is made to pass through the wheel a second time.

The reduction gear is of the double helical type, consisting of a single pinion with fixed bearings and on the main shaft is mounted the governor which controls the speed of the unit. The turbine spindle and pinion are made as one piece, supported on two bearings. Water seals are provided on the turbine shaft to prevent leakage of steam where the shaft passes through the turbine casing. The gear reduces the speed of the turbine from 6,900 to 575 revolutions per minute.

The pump itself is constructed with a cast iron body and a bronze runner mounted on a bronze encased steel shaft. Glands with flax packing, provided with a water seal, are fitted over the shaft at each end of the pump casing to prevent leakage. The main gear is mounted on the same shaft as the pump runner, which is supported by two bearings, the gear being overhung.

Lubrication of the entire circulating pump unit is provided from the main lubricating oil system.

There are two condensate pumps located beneath the condenser for extracting the condensate from the condenser. Each pump is of sufficient capacity to handle all the water at full power, the other being a standby for emergency use. These are centrifugal pumps, direct turbine driven. The pump runner and the turbine rotor are both mounted on the same shaft supported by two bearings, the pump runner being overhung.

The pump casing and runner are of bronze; the portion of the spindle contained inside of the casing is enclosed in a bronze sleeve.

At the point where the shaft passes through the pump casing there is fitted a packing gland, using flax packing and sealed with water from the discharge side of the pump chamber.

The turbine is of the single-wheel impulse type, similar to that driving the circulating pump, with bearings of the ring-oiled type. The spindle glands are fitted with a special form of adjustable metallic packing.

On the turbine end of the shaft is mounted a centrifugal governor, which operates a balanced throttle valve and so controls the speed of the machine. The turbine is designed to operate on a steam pressure of 175 pounds per square inch gage and a back pressure of 10 pounds per square inch gage. The normal speed is 2,700 revolutions per minute and there is developed about 5½ horsepower.

The condensate is discharged into a gravity tank, from which is taken the gland sealing water. From the gravity tank the condensate flows to the air separator and thence to the feed tank.

The air separator is virtually a jet condenser for condensing the exhaust steam from the air ejectors, the main condensate being used as cooling water. The air escapes to the atmosphere through a vent at the top, and to prevent the egress of objectionable vapors a small surface condenser is included in the top of the separator tank, for which cooling water is supplied from the main circulating system.

Two Westinghouse LeBlanc air ejectors are installed to extract the air from the condenser, either of which is of sufficient capacity to meet full load conditions, the other being provided as a spare. The air is withdrawn by means of multiple jets of steam in series which compress the air to atmospheric pressure. The mixture of air and steam passes into the air ejector tank, where the steam is condensed and the air escapes to the atmosphere.

By using air ejectors in place of air pumps, a very much simpler arrangement is obtained, which, besides requiring less attention in operation, takes up considerably less space. The ejectors are made of bronze, and are designed to operate on any steam pressure above 125 pounds per square inch gage.

The auxiliary condenser is cylindrical in shape, containing 800 square feet of cooling surface. Cooling water is supplied and the condensate and air removed by a combined circulating and wet air pump furnished by Dean Brothers.

Propeller Shafting

The main line shafting consists of six lengths of solid, forged steel, 13¼ inches in diameter and 23 feet 2 inches in length, fitted together with flanges and taper bolts.

The flange couplings are so designed that they may be readily held in perfect concentricity while the bolt holes are being reamed, and yet when finished there is no spigot fit to prevent one length of shafting from being lifted out without disturbing the adjacent units. This is accomplished by counterboring both halves of the coupling and inserting a well-fitted plug which remains in place during the reaming process, after which it is removed.

The coupling bolts are made with a moderately small

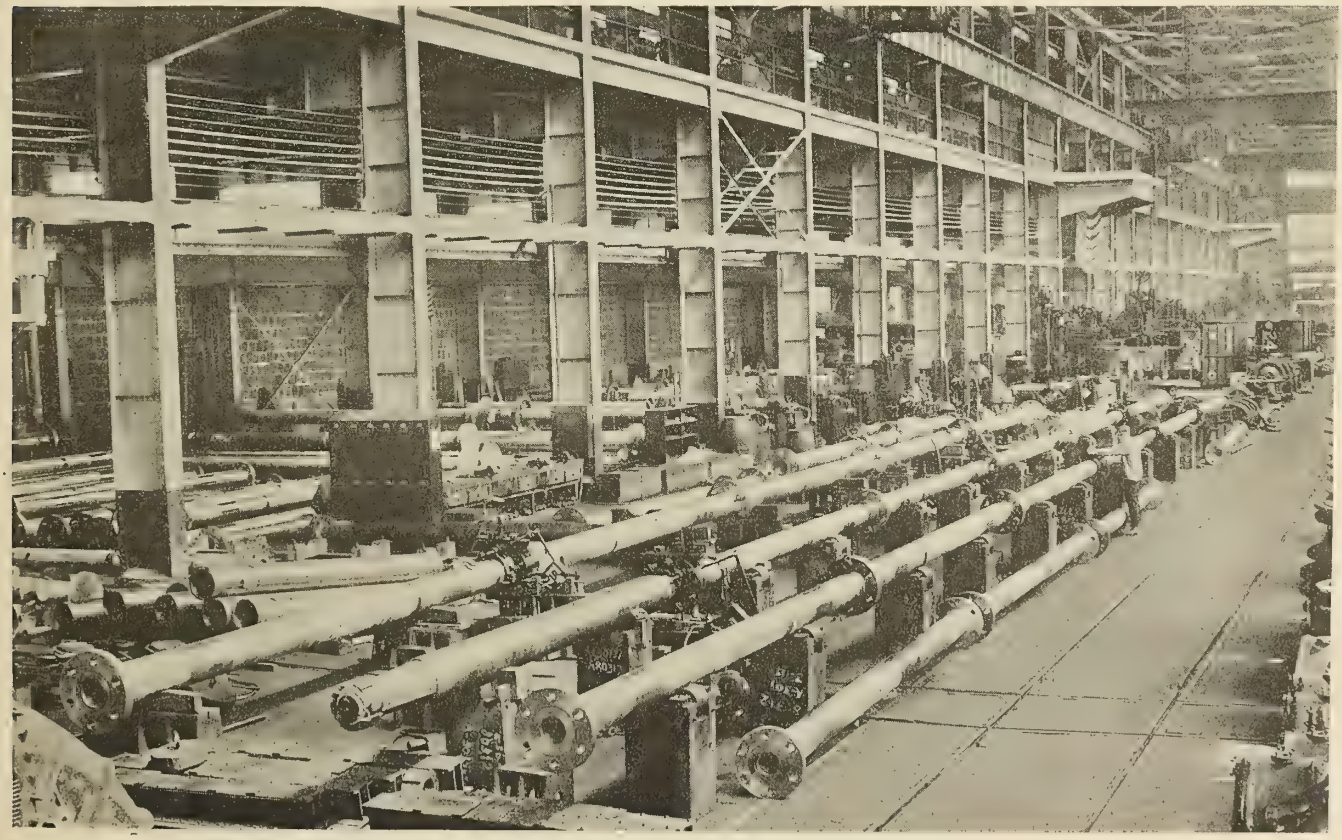


Fig. 35.—View Showing Line Shafting Set Up in Westinghouse Shops

taper so as to insure that the flanges will be properly drawn into place each time they are reassembled, and instead of having heads, the bolts are fitted with a nut at each end. The nut on the large end serves as a lock nut when the bolt is in place and gives additional power for holding the flanges together. Furthermore, it affords a very convenient method of backing out the bolt when disassembling.

Each length of shafting is supported by two ring-oiled bearings 18 inches long. The ring-oiling feature, although new in its application to marine line shaft bearings, is, of course well known in engineering practice, and the operation of the bearings on all of the ships in service has been unqualifiedly successful.

The tail shaft is 17 feet 6¼ inches overall, covered for almost its entire length by a bronze sleeve, shrunk in place.

The stern tube consists of a cast iron casing 9 feet 10½ inches long, in which are fitted two bronze liners with ligmum vitae bushings.

Machinery Weights

The actual weights of the various units of Westinghouse equipment are as follows:

	Pounds
Main high-pressure turbine	13,520
Main low-pressure turbine	17,270
Main reduction gear	63,800
Main steam strainer, 6 inches	350
Maneuvering valves, 6 inches	1,310
Cross-connecting piping and valves, including the four valves which control the emergency live steam	9,000
Main exhaust trunk	12,000
Main exhaust trunk expansion joint	120
Main condenser	29,600
Circulating pump unit	6,270
Two condensate pumps	2,040
Two air ejectors	180
Air separator	780
Auxiliary condenser, without pumps	7,250
Six lengths of line shafting and tail shaft	82,000
Twelve line shaft bearings	13,680
Sterntube	7,200

S. S. Guimba Hits a Mine

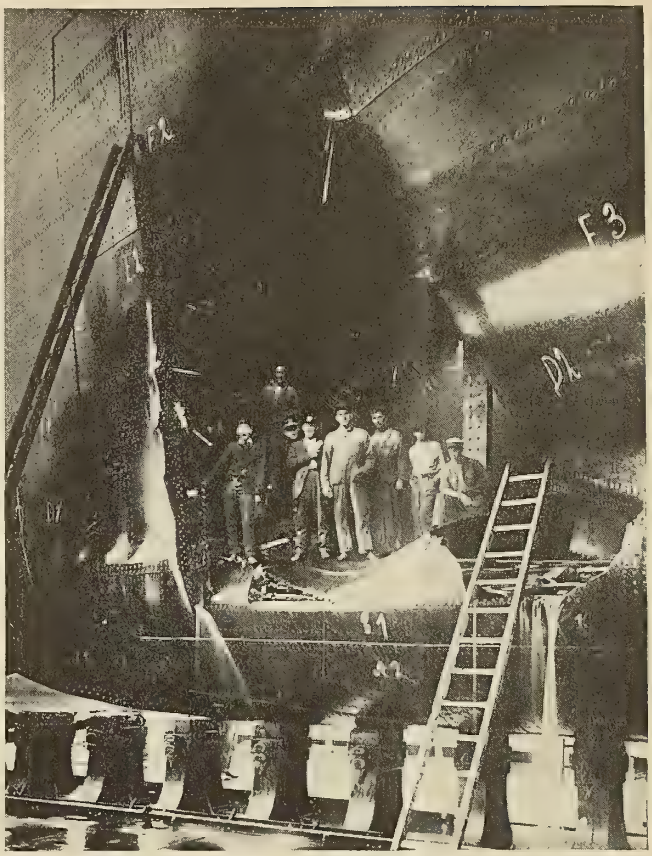
DESPITE the strenuous efforts of the mine sweepers, navigation in certain localities still remains extremely hazardous. The colossal tonnage loss sustained during the war is being added to by the presence of mines. Some idea of the danger that our ships have to contend with may be formed when it is stated that one ship alone reports having seen some seventy drifting mines within a comparatively small radius.

Of five United States ships that have struck mines since September, 1919, the S. S. *Guimba* was the only one saved, and this, it is said, is due to the fact that she was sailing only under sand ballast.

This ship is a steel refrigerator steamer of 6,149 gross tons and was built by the Moore and Scott Iron Works at Oakland, Cal. Her length overall is 416 feet 6 inches, her beam 43 feet, and depth 34 feet 6 inches. Propulsion is by Westinghouse compound turbines of 2,800 shaft horsepower. Two compressors of 80 tons capacity are used for refrigerating purposes.

The *Guimba* sailed for Hamburg on September 26, 1919, and, after unloading her cargo of frozen meat, left that port on October 18 on her return for the United States.

At half past two on the morning of the 19th, when some eighteen miles from the mouth of the river Elbe, a mine was encountered and a severe explosion took place. No. 1 bulkhead at her bow immediately admitted water, but, fortunately, No. 2 bulkhead was undamaged, and, despite the darkness and confusion, the ship was at once headed



Hole 18 by 24 Feet Torn in Port Bow of the *Guimba* by a Drifting Mine

about and succeeded in making port at Hamburg. Here she was put in dry dock and it was discovered that a hole of about 18 feet by 24 feet on the port side and two smaller holes of about 3 feet by 4 feet each on the starboard side had been blown in.

Repairs were made in 18 days, and eventually the *Guimba* sailed for New York, where subsequently she was docked.

Considerable credit is reflected upon Chief Engineer E. A. Partsch, a member of M. E. B. A. No. 13, for his energy and ability in contending with this emergency, and it is certainly a matter of congratulation to all concerned that it was not necessary to write this ship off as a complete loss.

A Practical Blue-Print Protector

Blue-prints are always getting dirty, wet, greasy or torn while being handled by workmen using them. An inventive genius has designed a very practical blue-print protector of simple construction and low cost. A sheet of transparent sheeting—the same material used for lights in auto curtains—is cut to desired size. A piece of lightweight leather substitute is then cut about a half-inch larger all around than the piece of sheeting. This extra half-inch allows for a lap-over on all but the top side of the protector. A sewing machine stitches the lap down to the sheeting, forming a large flat pocket, open at the top for the insertion of the blue prints.

Both the transparent front and the coated fabric back are water-proof and grease-proof. Dirt or grease may easily be wiped or washed off, either without injury to the material. Both materials are flexible and the holder may be rolled up if desired in the same way as an unprotected blue-print is usually handled by a workman.

Congress and the Merchant Marine Issue

BY WALDON FAWCETT

While there is not essentially and necessarily a close parallel between the general problem of railroad transportation in the United States and the principles and policies governing the nation's water-borne commerce, it is impossible to avoid comparisons just at this time, when the future of both elements is in a state of flux. In all candor may it be said that, despite the diversity of the interests involved, the development of a Congressional conscience with respect to the merchant marine should not be as slow a process as the building of a railroad "platform" were it not for the fact that the interests of labor enter into the one as into the other. Significant in that connection is the disclosure during the past month of the project of a certain political element to make government ownership—not merely government ownership of the railroads, but Federal operation of all public utilities and like enterprises—an issue in this year's Presidential campaign. As our readers fully realize, the issue of labor is a vital one not only for our shipbuilding interests, that will be called upon to meet sharpened competition from Japanese builders, but likewise for American shipping interests that felt, long before the war, the pinch of hampering exactions covering the human equation in ship operation. Just in proportion, therefore, as the labor issue enters, and just in proportion as a conclusive solution of that issue waits, will there be haze on the horizon of our merchant marine.

IN one respect the merchant marine situation in Congress has been clarified, namely, with regard to the disposition in certain legislative quarters to link the merchant marine issue with that of tariff revision and make the one, in certain respects, dependent upon the other. For some of the practical men in the shipping and shipbuilding industry it has been difficult to discern any pronounced interdependence between the problems of the American merchant marine and the system of United States customs duties, even though as an annex to the latter we have the proposition for "free ports" or "free zones." However, there has been at the Capitol a certain sentiment that favored consideration of the one responsibility in connection with the other. Therefore it is significant that the leaders in Congress have virtually decided that no general revision of the tariff schedules will be attempted during the year 1920, and that, in consequence, whatever action is taken in contemplation of the needs and possibilities of the Yankee merchant marine must be without regard to a change of tariff status.

Crystallization of popular sentiment on the merchant marine issue has not waited wholly upon the 1920 hearings before the commerce committee of the Senate which are counted upon to supply the best forum yet afforded for debate of the questions involved. On the eve of the opening of these hearings came the report of the referendum on a national merchant marine policy conducted by the Chamber of Commerce of the United States as a medium for the expression of the sentiment of the 1,200 trade and commercial organizations comprising the Chamber's membership.

The Effect of "Straw Votes"

In view of the overwhelming vote in favor of a general declaration by Congress of a policy to give aid to the maintenance of a privately owned and operated American merchant marine and for the continuance of operation of the competent American shipbuilding yards on private account, the question may be solicitously raised as to the weight which such pronouncements carry with the Congressmen who are ultimately called upon to vote on the propositions recommended. Generally speaking, it is to be feared that such "straw votes" do not mold Congressional sentiment as they should—not because the legislators intentionally flaunt commercial opinions, but simply because, too often, the substance of such symposiums is not brought emphatically and insistently to the attention of each individual lawmaker. It is always difficult to persuade the rank and file of busy Congressmen to spare the time to read carefully the voluminous record of Congressional committee hearings (such, for example, as the merchant marine hearings now in progress under the auspices of the Senate commerce committee), and it may be surmised that, with bodies all over the country constantly "resolving" on this subject, and that it requires a peculiar talent in insistence to impress indelibly upon the Congressional mind "memorials" bearing upon the merchant marine such as have come, latterly, not only from the National Chamber of Commerce but from other mouthpieces of big and little business.

Features Virtually Approved

On some of the incidental features of the merchant marine programme—for example, the proposition to give preference to American underwriters and the proposals for the encouragement of the American classification society—the powers that be in Congress are definitely "sold" and the enactment of enabling legislation seemingly waits only upon Congressional routine rather than halts before active opposition. The action of the framers of railroad legislation in striking out the provisions that would have extended the full measure of Federal supervision to inland waterway and coastwise shipping was, for the time being, eloquent of the growth in Congress of a sentiment for freedom on the part of the merchant marine from government regulation of routes and rates. Just so long, however, as any political element flirts with the idea of Government ownership will there be justifiable speculation as to the immediate and ultimate effect upon merchant marine policies.

It is by no means certain that the tentative proposal to stretch the railroad regulatory measures to encompass shipping has not proven, in one sense, a blessing in disguise. Raising of the issue has brought to Congress a wealth of first-hand information on the conditions and problems of American inland waterway and coastwise commerce that would not, perhaps, have been acquired in any other way and that may prove valuable in the

determination of all public policies affecting this important section of the nation's water-borne commerce. Distinctly illuminating, for example, have been the data assembled with respect to shipping and shipbuilding on the Great Lakes—a section of the industry whose importance was so strikingly attested during the world war.

Interests operating "wild" boats on the Great Lakes have strongly endorsed the contention of their brethren who operate "tramp" vessels on the ocean to the effect that there should be exempted from all Federal jurisdiction as to rates the "port to port" traffic the compensation for which has, from time out of mind, been determined by the Yankee process of bargaining. In like manner has it been urged that a corresponding immunity should extend to the port-to-port business of the lines operating on regular schedule, but which are required, in the case of upward of 50 percent of their cargoes, to come into direct competition with the "wild" or "tramp" steamers. It has even been suggested that an equitable adjustment of this shipping situation would require not merely an absence of new legislation on the subject, but likewise a modification in some respects of the jurisdiction already exercised by the Interstate Commerce Commission. Generally speaking, though, the attitude of the shipping interests of the Great Lakes, as translated to Washington, has been favorable to a status that would avoid any disturbance of the conditions heretofore existing—a status the continuance of which was, in effect, approved when the Shipping Act, that was placed on the statute book several years since, expressly exempted the bulk freighters. Quite equal to the representations with respect to Great Lakes shipping has been the impression left with Congress of the necessity for reasonable elasticity in rate making on the part of the coastwise lines.

Responsibilities of Water and Rail Carriers

Certain coastwise shipping interests, notably those engaged in the Alaska trade, have been at pains to make it clear to Congress that one ground for fear of the consequences of an extension to shipping interests of the full jurisdiction of the Interstate Commerce Commission is found in the responsibilities that would be imposed through what is known as the Cummins amendment to the Interstate Commerce Act, an amendment providing that all carriers subject to the act shall be liable for the full value of any loss or damage to goods in transit. The discussion in this connection has opened up the whole subject of the relative responsibilities of water carriers and rail carriers, the judicial aspect of which issue will probably shortly be disposed of in test cases now pending in the Federal courts. Naturally, the shipping men who have been appraised of the situation have viewed with misgivings any prospective turn of affairs that would disturb the different standard of liability which the leading maritime nations of the world have heretofore recognized for water carriers in contrast to that enforced upon land carriers.

One class of shipping interests, namely, those concerned with the utilization of the transportation facilities of the Mississippi river and tributary waterways, has seized upon the opportunity afforded by the discussion of the issue of railroad control to bring forward an entirely different issue, viz., the alleged repressive effects of railroad competition upon river commerce. Representatives of the Mississippi Valley Waterways Association and similar organizations appearing before Congressional committees have charged that the railroads have been permitted to make such "low and ruinous" rates to river points as to make it unprofitable for boat lines to operate upon the rivers, the losses thus incurred by the railroads being made up to them through the imposition of high rates to inland points. It having become evident that Congress is in a mood to overhaul the railroad legislation now on the statute books, the river shipping interests have come forward with the plea that new or supplementary legislation be enacted that will compel the railroads to recognize the inland waterways transportation interests as common carriers and to co-ordinate and co-operate with them as the railroads do with one another. Apropos this same agitation we have bills now pending in Congress to transfer the transportation on the lower Mississippi and that which is expected to be developed on the upper Mississippi to the United States Shipping Board.

Inland Waterway Navigation

It is not improbable that the mere circumstance of the return of the railroads to private management on March 1, irrespective of the exact terms of the railroad legislation that will be agreed to in the meantime, may operate indirectly to bring to a head the long festering issue of the proper capitalization of American inland waterways as arteries of commerce. During the past few years there has been more or less activity in the field of inland waterways shipping on the part of the Inland Waterways Division of the Railroad Administration. With the return of the railroads these arrangements will necessarily come to an end and there will be increased insistence on the part of persons directly interested that some definite steps be taken to restore the rivers to their old position as highways of commerce. Various proposals to this end have already been formulated, including the project which has been before Congress for some time past for the creation of a permanent inland waterways commission. Hung up with the general issue in this same connection is the question of adequate terminals, which is accounted by many shipping men the tender spot of the whole subject. The Railroad Administration has had in contemplation the provision of suitable terminals at strategic points, say at Cairo, Ill., and now, if the withdrawal of the Railroad Administration ends initiative in this quarter, the responsibility will be thrown back upon the cities which, with the exception of New Orleans and St. Louis, have not responded as they might to the need for terminals.

As pertinent, in view of the prospective return of the railroads to private management, it may be worth while to give a glance in passing to what has been accomplished by the Inland Waterways Division of the Railroad Administration, an institution that has functioned in two sections, namely, the New York Barge Canal Section and the Mississippi and Warrior River Section. In the case of the first-mentioned section expenditures have aggregated in the neighborhood of $4,500,000 (£925,000), providing for the construction of 51 steel and 21 concrete barges, 21 self-propelled steel barges and the purchase of 5 tugs and 3 barges. On the Mississippi-Warrior Section the authorized programme has called for upward of $10,000,000 (£2,050,000), this being designed to provide 6 towboats and 40 steel barges of 2,000 tons deadweight capacity, which are now being delivered at the rate of 5 or 6 a month, in addition to a number of wooden barges. A complete fleet of the new boats cannot be available before next summer, and there will be regret if any circumstance interferes to prevent a try-out on the lower Mississippi of the tow and barge system under favorable conditions.

Settlement of War Claims

During January the builders of wooden ships, who are seeking redress from the Government on more or less

"intangible" war claims, had their "day in court" before committees of both the Senate and House of Representatives, and the consequence is that the national legislature seems to be in a fair way to provide a basis of settlement for claims based on verbal agreements. This is not saying, however, that it may not be a matter of weeks before the Shipping Board is empowered to adjust the equitable claims of the wooden-ship builders. There are several different proposals before Congress on this issue, viz., the bill of Senator Jones of Washington, the measure introduced by Representative Greene of Massachusetts and the proposal of Congressman Johnson of Washington, and a certain amount of time will be required to iron out the differences or discrepancies between these several programmes, all of which aim at the same objective.

Admiralty Suits Against the Government

The past few weeks have also witnessed significant progress in the effort to obtain at Washington authorization for suits against the United States in admiralty, etc. This is a boon which has been earnestly sought by shipping interests speaking through the instrumentality of the Maritime Law Association of the United States, and the committee of the judiciary of the House of Representatives has been wrestling, in consequence, with the whole question of fixing the status of government-owned or operated vessels. Latterly, pressure has been strong for the extension of the scope of the contemplated legislation to cover naval vessels, army transports, etc., as well as merchant vessels. On the other hand, there has been encountered strong sentiment in the judiciary committee against affording any form of relief for maritime torts that might operate to tie up or interfere with the operation of naval or military craft in time of war. At this writing the outlook is for a compromise that will provide means for compensation to shipping interests for damages caused by negligent navigation of a public vessel of the United States, but that will be hedged with limitations that will preclude the possibility of interference with the operation of any Federal craft in time of emergency.

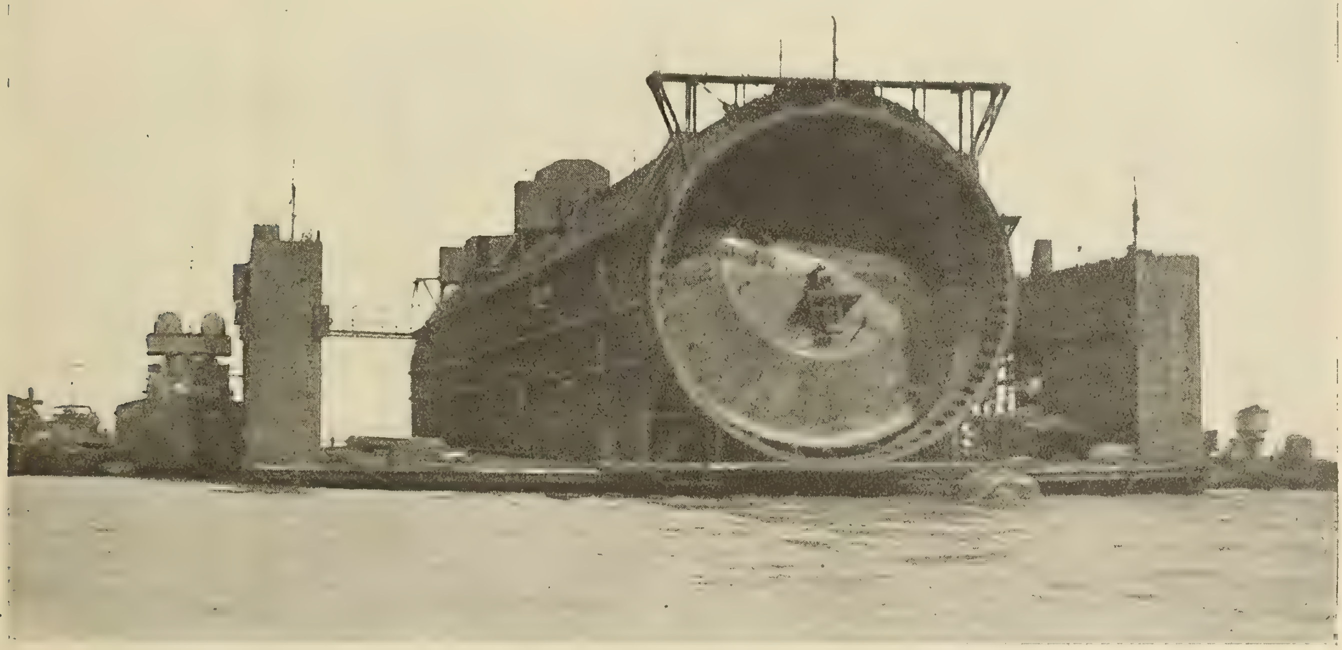
In contemplation of the formulation of a definite and permanent governmental policy on the general issue of the merchant marine, no little discussion has been precipitated in Congressional circles by the belated revelation to members of the facts presented some months ago to the Senate committee on commerce by J. H. Rosseter, director of operations of the Emergency Fleet Corporation. Director Rosseter made his disclosures in executive session, and it is only lately that it was decided to take the full membership of Congress into the confidence of the committee with respect to the evidence submitted.

Offsetting Higher Shipbuilding Wages

Director Rosseter discussed, among other things, the possibility of offsetting the world-wide tendency to higher wages in the shipping industry by improvement in the speed of vessels and improvement in the facilities for handling cargo, thus reducing the time in port. In answer to pointed questions he declared his confidence that, with all the Government vessels built or building turned over to private interests, American shipbuilders will be able to compete with foreign builders and American ship operators will be in a position to compete with foreign owners. But, he added, "We must have fair treatment for our ships. I have always contended that in the past, instead of encouraging, we have persistently discouraged the maritime enterprises of our people. We should now tear down that discrimination and replace it with a fair measure of encouragement."

Great Britain Secures German Submarine Testing Tank

When Germany undertook to conquer the world by relentless submarine warfare she had as a part of her naval equipment a large cylindrical floating tank in which her submarines could be subjected to any desired pressure in order to test their strength and watertightness. By means of these tests the fitness of the vessel for submergence to predetermined depths could be ascertained without the hazard of sinking the vessel in deep water. This tank, which has been allocated to Great Britain, can be seen in the photograph below, lying at anchor in the harbor at Harwich, England.



(Photograph by "International," New York)

German Submarine Testing Tank Allocated to Great Britain

Fig. 1.—Bulk Grain Storage Plant of 1,200,000 Bushels Capacity on Pier 1

Shipping Facilities of the Port of Astoria*

As an example of the excellent shipping facilities which may be developed by careful planning in a harbor providing deep water, we give in this brief article an account of the construction work completed or in process at the Port of Astoria, Oregon. Her three broad piers over 1,000 feet long, two already in operation, will be threaded with conveniently located railroad tracks and equipped with the most modern types of handling machinery especially adapted to the needs of the material exported and imported through this harbor.—The Editor.

THE Port of Astoria, located on a peninsula between Youngs bay and the Columbia river, ten miles from the ocean, is well situated for the development of extensive ocean commerce. The entrance to the harbor has a depth of 42 feet of water at mean low tide and the channel is 3,000 feet wide. Eight square miles of anchorage with a depth varying from 30 to 70 feet at mean low tide are provided, with an additional 12 square miles varying from 24 to 70 feet in depth. The harbor, which is fresh water, is free from ice and protected from swells by specially constructed jetties.

The total berthing space of the wharves in the harbor will be 11,714 linear feet—1,723 feet water frontage for Pier No. 1, 3,178 feet for Pier No. 2. Pier No. 3, for which the Foundation Company, New York, has recently received the construction contract, will have a berthing space of 3,875 feet.

Development of the Harbor

In 1913 a small tract of waterfront property comprising 56 acres near Smith's Point, on the main channel of the Columbia river, was purchased by the port commissioners. Upon this site Piers 1 and 2 have already been constructed. All wharves are served by the Spokane, Portland and Seattle Railroad Company in direct rail communication with the interior on a water level grade.

Construction Details of Pier No. 1

Pier No. 1, which has a frontage of 620 feet, is 1,363 feet long, with a total area of 806,000 square feet entirely bulkheaded and filled in. Upon this pier are located a freight shed, a bulk grain and storage plant, extensive railroad trackage, a 4,000-barrel capacity flour mill, and additional freight sheds, providing 65,000 square feet of covered storage space. These sheds are equipped with mechanical ramps for loading and unloading commodities from barges and vessels. Eight portable conveyors are used for the handling of grain, flour and other bulk freight to and from the cars and to the ship's hold. Each of these conveyors handles a maximum load of 100 tons per hour, depending, of course, upon the labor available on the ships to stow away the cargo as it is loaded.

Chutes and sliding doors have also been constructed to load sacked freight into the holds. The 1,200,000-bushel

* This article has been prepared from data furnished by R. R. Bartlett, manager and chief engineer of the Port of Astoria, and by the Foundation Company, New York.

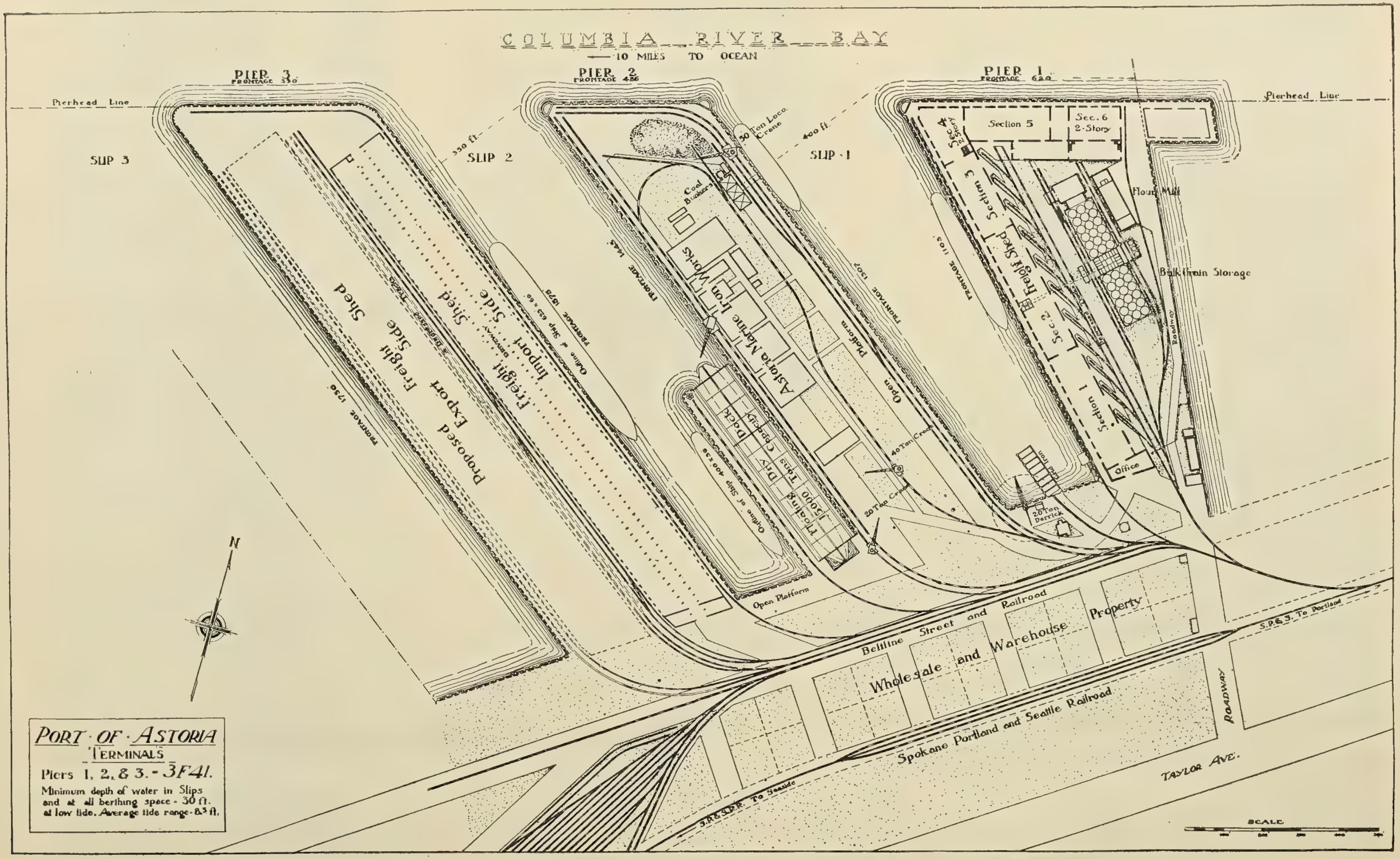


Fig. 2.—Map of Port of Astoria Terminals, Showing Arrangement of Piers 1, 2 and 3 and Rail Connections

Fig. 3.—Panoramic View of Pier 2, Showing

Fig. 4.—Coal Storage Facilities

bulk grain plant, built of reinforced concrete, has been in operation since 1918. Two storage units are made up of 64 tanks; the main tanks are 28 feet 6 inches in diameter by 78 feet deep. The flour mill, a five-story structure, also of concrete, is now being built.

Mechanical pilers, trucks, catch-alls, slings, chutes and other mechanical devices are installed for unloading canned goods at the rate of 1,000 cases per hour. Automatic checkers are also used in this work.

The arrangement of the railway tracks makes it possible to place cars close to the water's edge for handling freight direct to the vessel's hatches. Three rail tracks are provided along the front of the dock. Depressed herringbone tracks of special design permit the unloading of three cars from one warehouse door. The bulk grain plant is served by four tracks. The total trackage on the pier will accommodate about 100 cars. Three locomotive cranes of 30, 40 and 50 tons each serve this pier.

Facilities of Pier No. 2

On Pier No. 2, which is 426 feet wide and 1,445 feet long, coal bunkers are operated over gravity discharge and apron conveyors to telescoping chutes, which deliver the fuel direct to the ships' bunkers. Cranes similar to those installed on Pier No. 1, with an additional electric

Fig. 5.—General View of Port of Astoria Terminals, Showing

Its Great Length and Bunkering Facilities

derrick of 20 tons' capacity, handle lumber, coal and all classes of heavy package freight expeditiously. The railroad tracks are constructed on both sides of the bunkers and storage piles to facilitate unloading.

15,000-Ton Floating Dry Dock Planned

Plans are still under consideration for the construction of a 15,000-ton floating dry dock. In the plan of the terminals shown in the accompanying illustrations provision is made for the location of this dry dock in slip 2 off Pier No. 2, a sheltered location accessible to railroads and shops. This construction, however, has been temporarily held up until more urgent work has been put through. At present, repairs are handled by the Marine Iron Works, located on the same pier.

Between Piers No. 1 and No. 2 a gridiron has been built for transferring cars or rolling stock from railroad tracks to barges. Landing floats with adjustable gangways and electrically operated truck boosters have been conveniently located at the end of slip 1 to aid in the delivery of materials from wagons to small boats, or from river barges to the dock level.

The award to the Foundation Company, New York, of contracts for the construction of Pier No. 3 and freight shed No. 4 marks another step in the develop-

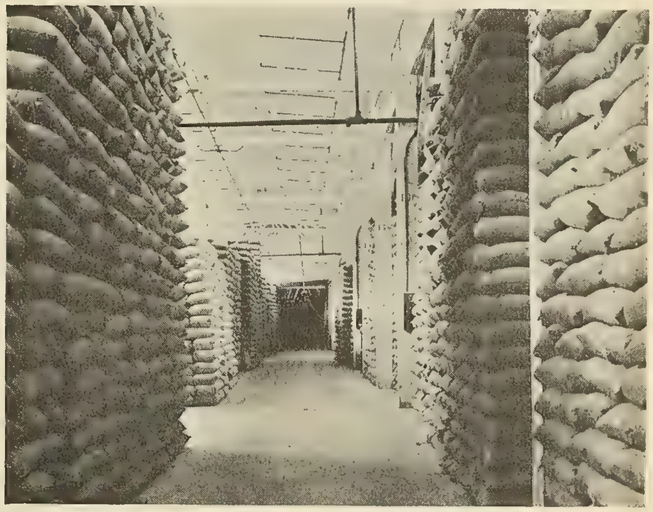


Fig. 6.—High Tiering in Pier Shed

Piers 1 and 2 in Operation. Wooden Shipyard Can Be Seen at the Left

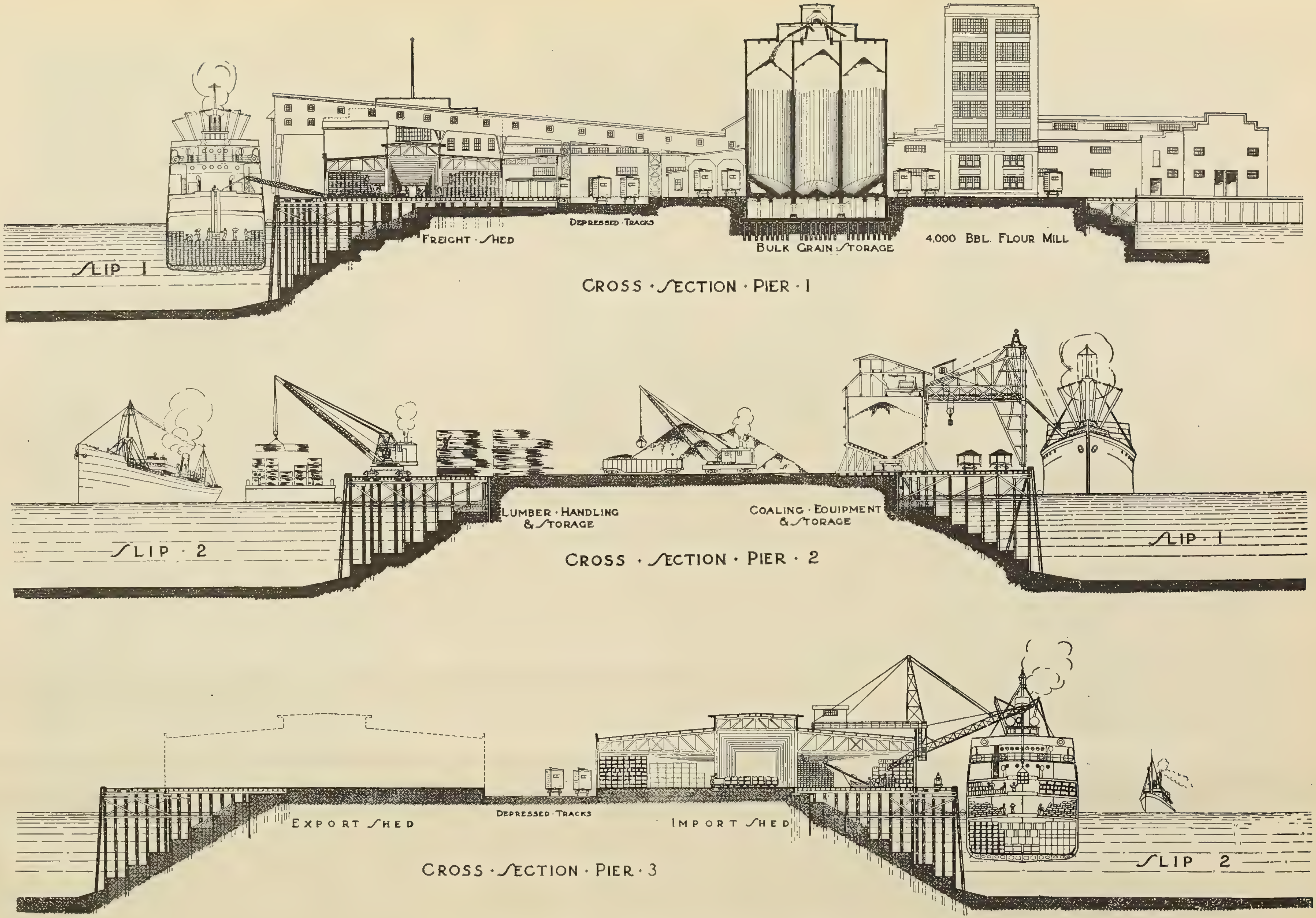


Fig. 7.—Sections of Piers of Port of Astoria Terminals

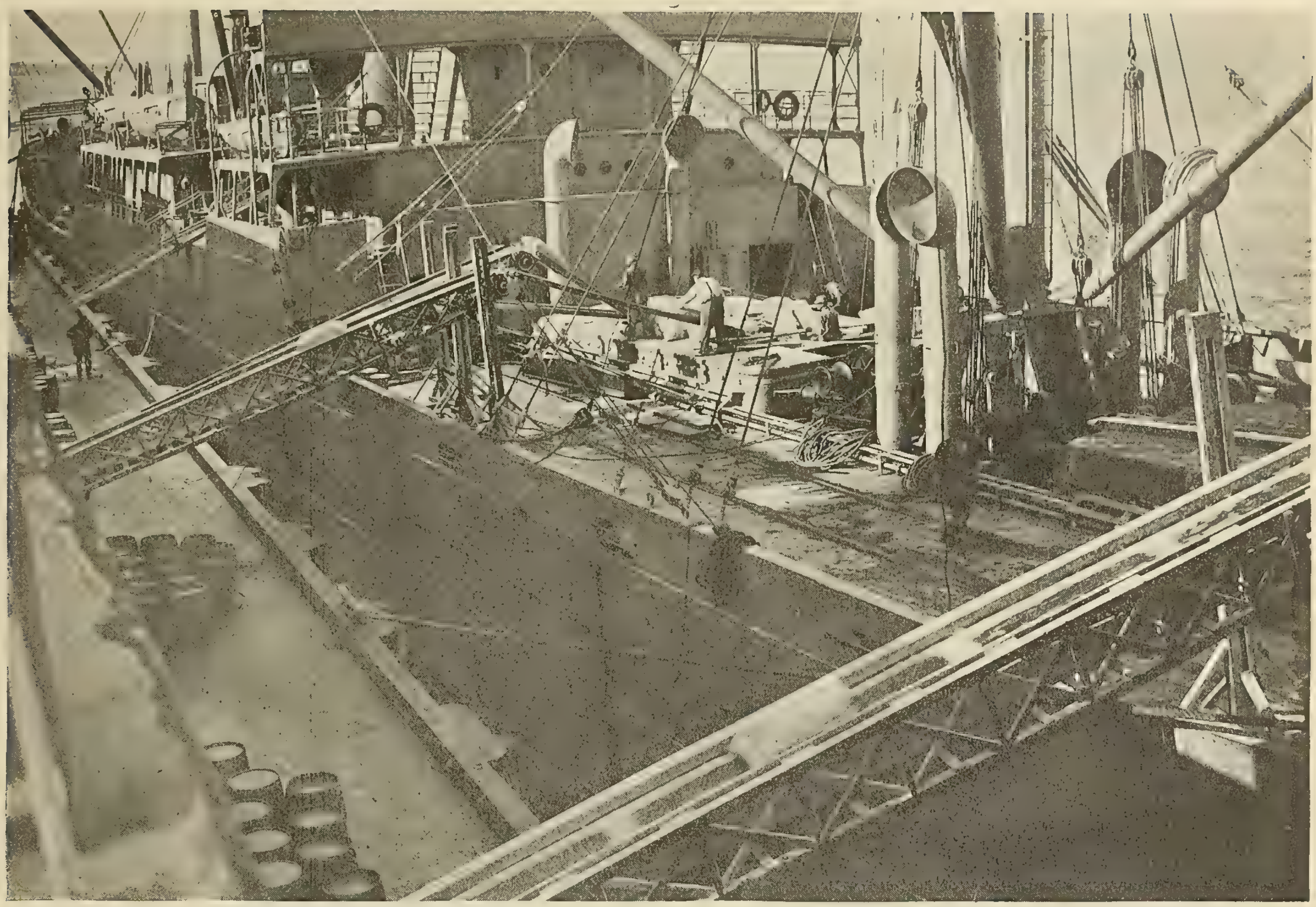


Fig. 8.—Mechanical Conveyors Assist in Loading and Discharging Vessels

ment of the far-sighted policy adopted by the Port of Astoria Commission. Preliminary estimates placed the cost of this work at about $800,000 (£164,000). This pier, upon which work has just been begun by the Foundation Company, will have a total frontage, as previously mentioned, of 3,875 feet.

The pier will be occupied by two sheds, one for import and the other for export freight. Only the import shed is included in the present contract. As may be noted from the accompanying cross-section, Pier No. 3 will consist of a solid fill surrounded by a wooden deck 74 feet wide, supported on piles. The interior fill is to be placed by the Port Commission, but the contractor is required to provide bulkheads between pile bents to retain the sluiced material. At the outer end of the pier the bulkheads reach a depth of 40 feet. The slope of the fill between bulkheads is to be riprapped, which will involve the placing of 11,000 cubic yards of stone.

The pile bents under the deck are on 10-foot centers, the piles being placed 6 feet apart. Caps, 14 inches by 14 inches, support 6-inch by 14-inch stringers, which carry the 4-inch deck plank. The latter is protected by a wearing surface of asphalt 1 inch thick. The entire pier will require about 5,200 piles between 40 and 100 feet long and about 4,000,000 feet board measure of lumber for framing, bracing and decking.

Pier Shed No. 4 will be about 1,600 feet long and 160 feet wide, with reinforced concrete walls, wooden posts and timber truss roof, used in the interior. The posts divide the interior space into three bays, the center bay having a width of 40 feet and the side bays 60 feet. The construction work will require the placing of 6,000 cubic yards of concrete and the framing of about 2,000,000 feet board measure of lumber. The contract calls for the completion of the work in one year, but the Foundation Company believes that it will be possible to turn over the pier to the Port Commission early in the summer of 1920.

The construction of this pier will be under the immediate supervision of W. A. Hanscom; M. T. Stack is the superintendent for the Foundation Company under the direction of Bayly Hipkins, vice-president, in charge of operations on the Pacific coast.

Upon three modern piers providing a berthing space of 11,714 feet, the Port of Astoria, Ore., plans to operate a large import shed, coal bunkers, a flour mill and a grain storage plant. The import shed now under construction is 1,600 feet long. Mechanical handling equipment now installed includes a 48-foot by 150-foot gridiron for loading locomotives and rolling stock, electrically operated truck boosters, eight portable conveyors, four electric portable piling machines, locomotive cranes, 39 electric motors, a traveling belt coal weightometer, two floor track automatic checkers, four manila catch-alls, 48 plank case slings and 16 chutes and sliding boards.

European Motorship Developments

Largest Shipyards Vigorously Attacking Oil Engine Problems—Vickers System of Solid Injection—Electrically Welded Motorship

BY OUR SPECIAL LONDON CORRESPONDENT

PROBABLY one of the most interesting, and certainly one of the most significant features of the present development of marine oil engine construction in Europe is the fact that all the largest concerns are now devoting a great part of their enegry to this problem, and such world-renowned concerns as Vickers and Armstrongs are participating very actively in the new industry. In the majority of cases the leading marine engineering firms have converted their workshops, which during the war were employed for the manufacture of Diesel engines for submarines, to fabricate for the construction of low-speed mercantile oil engines, and arrangements in all cases are being made for rapid production on a standardized basis.

The work which is now being carried out by Vickers is of special interest. Two 10,000-ton motor oil tankers are being built by this firm for the Anglo-American Oil Company, and the first has already been launched, while the two engines are practically ready for installation in the new vessels. A brief description of these motors will be of interest, as they they represent a design embodying all the features which Vickers have found to be most satisfactory during their long experience with submarine engines, although they have, of course, specially adapted them for heavy, slow-running motors. Two engines are to be installed in each ship having six cylinders 24½ inches in diameter with a stroke of 39 inches, developing 1,250 brake horsepower, or about 1,600 indicated horsepower at 118 revolutions per minute. It may be added that this size of engine has been decided upon as being suitable for installation in the average type of cargo vessel of about 10,000 tons deadweight carrying capacity with a speed at sea of from 10 to 10½ knots.

Diesel Engines with Mechanical Injection

The most novel feature in the design from the point of view of the engineer accustomed to Diesel motors is that the well-known Vickers system of solid injection of fuel is employed, instead of providing a three-stage, high-pressure air compressor for blowing the fuel through the fuel valve nozzle, at a pressure of about 1,000 pounds per square inch. In these Vickers engines there are four fuel pumps driven in pairs by means of two eccentrics on a horizontal spindle which derives its motion from a vertical shaft. This shaft, which is driven from the crankshaft, drives at its upper end, through bevel gearing, the camshaft, on which are located all the cams for operating the inlet, exhaust, fuel and starting valves.

The fuel injection pumps, which are of the plunger type, operate at a pressure of about 4,000 to 4,500 pounds per square inch, and if it may appear that this high pressure is a source of danger it should be remarked that the same system has been employed on the large majority of British submarines and no accident has been recorded. In fact, the tendency is to increase the pressure still further, and in the solid injection system, which is used by Doxfords in their new type of Diesel engine, the pressure rises to as much as 7,000 or 7,500 pounds per square inch.

The valve gear is of a new type. In each cylinder cover is the fuel inlet valve in the center, together with an inlet and an exhaust valve on each side. These are all operated through valve levers from the cams on the horizontal camshaft mentioned above, and in order to provide for reversing, each valve has two cams side by side—one for ahead and one for astern running. On reversing when turning the reversing lever this actuates a Servo motor, which, by means of a lever, rotates the spindle upon which the valve levers are eccentrically mounted. The valve levers are thus lifted off the cams and the camshaft is then moved fore and aft by means of the reversing wheel. After this movement the valve levers are then brought down onto the cam once more, the main starting air valve is opened, admitting compressed air to the six cylinders. The next movement of the maneuvering wheel puts two of the cylinders on fuel and two on air, and finally the air is cut off and all the cylinders are put onto fuel.

In accordance with a design which is now becoming more common in British Diesel engine practice, the starting valves are not arranged in the cylinder cover itself, but below the camshaft operated by means of levers from cams on the shaft. From these valves pipes are taken direct to the cylinders, so by this means some simplification of the valve gear is effected. The exhaust valves are water-cooled and the pistons are cooled by lubricating oil, while the cylinders are, of course, cooled by means of sea water, a somewhat novel feature being the fact that the water enters at the top and goes downward, which, it is thought, will prevent any tendency for the cylinders to become choked up with mud.

Cammell-Laird's Novel Diesel Engine

The employment of electric welding on ships has attracted some interest in America, so that the new motor vessel which is now being completed by Cammell-Laird, and in which the whole of the work has been carried out by electric welding, will no doubt be closely watched in that country. The engine for this ship is the first of its type, but two further sets of the same design are being built to be installed in an Anchor Brocklebank cargo boat now under construction on the Clyde. This latter ship will be a vessel of about 8,000 tons, and the two motors are each of 900 horsepower (1,200 indicated horsepower), having four cylinders 18½ inches in diameter, with a combined stroke of 50 inches. The engine is built in two units of two cylinders each, and the opposed piston system is adopted, the top and bottom crossheads of adjacent cylinders being connected with diagonal rods. At the top of the cylinders the crosshead is formed into the piston of a scavenging pump, supplying scavenging air at a pressure of 1½ pounds per square inch, which is admitted to the bottom of the cylinder through ports in the periphery. The exhaust gases escape through ports at the top of the cylinder, so that there only remains the fuel valve actually in the cylinder itself. This is arranged horizontally in the center of the cylinder, the fuel being injected by compressed air just before the two pistons reach their point of nearest approach.

As in the case of the Vickers engine, the starting air valve is not in the cylinder, but is external to it with an air pipe leading to the cylinder, connection being made

through a non-return valve. The fuel valves and also the external starting air valves are actuated by levers from cams on the camshaft, and when reversing this camshaft is rotated through a certain angle relative to the crankshaft, thus altering the timing of the fuel valves. This system is one of the simplest available and can be most satisfactorily employed in engines of the two-cycle type when there are only the fuel and starting air valves to be altered according to the direction of operation.

German Motorship for British Owners

Three interesting German motorships have recently been handed over to Great Britain in accordance with the peace terms. These are the Krupp-built *Loki*, the *Wotan* (built by the Reiherstieg Company) and the *Fritz*, constructed by Blohm and Voss. The latter, which has been acquired by the Glen Line is of unusual interest, in that two double-acting, two-cycle engines of 900 brake horsepower are installed. She is thus the only vessel in which double-acting motors are fitted. The engines have three cylinders with a bore and stroke of 18.9 inches and 26.4 inches respectively, running at 120 revolutions per minute. The scavenging pumps are fitted at the back of the engine and driven from the crosshead by rocking levers, and there are three fuel valves for each cylinder—two at the bottom and one at the top, the two at the bottom being necessary owing to the fact that the piston rod passes through the bottom cylinder cover.

Both the *Loki* and the *Wotan* are equipped with two-cycle motors, the latter being a single-screwed vessel with an 1,800-brake-horsepower engine and the former a twin-screw ship with two 1,250-brake-horsepower sets. In view of the fact, however, that the sister ship to the *Loki* (named the *Hagen*) proved a failure and the oil engines were replaced in America by steam engines, it is not thought that she will be found a particularly successful type of craft. It is, in fact, stated that Krupps have abandoned this design for four-cycle engines.

Operating a Large Marine Diesel Plant

BY E. N. PERCY

Many marine engineers, thoroughly at home in the engine room of a steam vessel, are beginning to show a lively interest in the operation of Diesel plants on motorships. In particular they wish to know how the work differs from steam engine work. In the first place, it may be said that any competent marine engineer, capable of operating a steam plant, can learn to take care of a Diesel plant by starting in as a second or third assistant and applying himself assiduously to mastering the details of the Diesel oil engine and its auxiliaries. On the other hand, to take a job as first assistant or chief engineer would be inviting trouble. Just what the conditions are is shown in the following article.

There is no mystery about Diesel engines, and an exposition of their working principles can be found in any good text-book on the subject. A good Diesel plant is a "home" and far less work to maintain than the average steam plant; in fact it can be maintained with almost no work in port. A poor or cheap Diesel plant, and particularly a semi-Diesel plant, requires much hard work to keep it in proper condition, particularly as such ships are often in the hands of owners who begrudge any outlay for maintenance.

High-grade engines are of the slow-speed, heavy type, equipped with the full, force-feed, circulating system of lubrication, and with all auxiliaries except the compressors driven separately from the engine. In very large engines even the compressors are separately driven.

Types of Engines

Engines up to 500 horsepower are usually of the trunk piston type. Larger engines are of the crosshead type, built just like a marine steam engine, except that they are enclosed with light covers and flooded with circulating oil. Instead of water-cooled bearings, the oil is cooled in a separate cooler. The oil is also filtered. In the case of a crosshead engine, a bulkhead separates the crankcase from the cylinders and protects it from the dirty oil drippings of the cylinders. The pistons are water-cooled, as a rule, in engines above 500 horsepower.

The Diesel engine is a splendid and reliable servant to one who understands it, but with an unsympathetic operator it tends to act very much like a boiler in the hands of an ignorant water tender. There are things about both of them that can't be put in books—certain well-known signs—the "feel" of things, sounds, familiar vibrations, temperatures, oil sight feeds, pressure gages, etc. The Diesel engine speaks a much plainer language than a boiler and will tell one more; but— one must learn the language.

Starting up a Diesel plant is much like starting up a modern steam plant, except that it is not necessary to "warm up" anything. The Diesel engine will, after proper inspection, start right "off the bat" after a month's or a year's stop and carry full load within thirty seconds.

Auxiliaries Started First

The engineer on watch will first have an auxiliary engine running, so as to have electricity. Practically all large Diesel ships now have electric auxiliaries. If the ship is "dead"—that is to say, has no engines running and no air on hand to start them—the "emergency" compressor is started. This is a small compressor coupled to a small steam engine on the donkey boiler, or a small gas engine, or a small semi-Diesel engine which can be started by hand. This compressor is then operated until enough air is in one of the smaller bottles to supply injection and starting air for one of the large auxiliary engines. Every Diesel ship has from two to four auxiliary electric generating sets ranging from 50 to 200 horsepower, according to the size and type of ship.

When the larger engine can be started the auxiliary electric compressor is then started. Sometimes this compressor is direct-coupled to one of the auxiliary engines instead of a dynamo. Sometimes both are coupled to one engine with clutches.

The auxiliary compressor is then operated until the maneuvering air tanks are fully charged—usually to about

350 pounds per square inch. Then the injection air bottles on the main engines, the reserve injection air bottles and the bottles on the auxiliary engines are charged. These various bottles are carefully shut off after charging, except those about to be used in starting the plant.

After the bottles are all charged and a good supply of air is on hand and the electric plant is running in good shape, the fuel transfer pump is started and the day tanks filled with oil from the main storage. This gives the oil a chance to settle. There should be at least one day tank which had been previously filled and allowed to settle for some hours. Any water in the bottom should be drained into a bilge pump. This tank may then be connected to the main engine and auxiliary engine fuel pumps. The hand pump on the main engine is then used to fill the fuel system of the main engine with oil until the try cocks at each injection valve show oil.

The circulating water pump should be started before the main engine is moved for any purpose whatever. The same may be said of the circulating pump for lubricating oil.

The electric bilge, sanitary and fire pumps are used the same as in a steamship. The maneuvering and injection air may then be turned on the engines.

Handling the Throttle

The modern large Diesel has either a handwheel for reversing or an air-ram with oil cylinder. The "throttle" is a rather complicated affair, although very simple to operate. It consists, as a rule, of two levers, one for each half of the engine. When these levers are pulled one way they are air throttles and start the engine just like a steam engine. When shoved the other way they are oil throttles and start the engine off as a Diesel. These throttles also operate the air-starting valves and throw them out of gear when no longer needed. They also operate the relief valves to prevent a cylinder from hanging up against the high compression. The throttles shut off the oil and injection air until swung over to the oil side. They also operate on the governor to regulate the speed of the engine.

The operator must, of course, learn to maintain and adjust all these parts, but they are not nearly as complicated as the condensing and feed water system which the average steam engineer knows so well.

After the maneuvering air is turned on, the reverse may be tried out and the engine turned over a few times forward and back to make sure that all is clear and that she "takes" the oil. At first the operator may be a little timid, but as he becomes familiar with the engine and learns to connect cause and result, and knows the few things that interfere with the proper operation of the engine, he comes to have great confidence, because he knows that no matter what happens he will understand it and quickly remedy the trouble.

Starting the Engine

A Diesel engine starts very suddenly compared to a steam engine, and almost instantly gets into its stride. It is customary to start the whole engine on air, then swing half the engine to oil. If it "takes," the other half is swung over also. If it does not "take" and the bridge has transmitted an order, it is pulled back to "air" and the other side tried on oil. An engine that may hesitate slightly on starting will usually go off fine when dragged a couple of turns by the other half. The relief valves usually spit when a Diesel starts; so, all told, it does not appear so smooth and easy as a steam engine, but one soon becomes accustomed to the peppery ways of a Diesel and acquires a liking for its willingness to be up and doing.

If considerable maneuvering is expected the auxiliary compressor is started. One need not feel nervous about keeping it running or shutting it down, as on a modern well-designed plant the air pressures rise and fall very slowly and there is plenty of time for everything, even if bells come in fast for a couple of hours, as in a difficult piece of docking.

Adjustments Easily Accomplished

While a Diesel looks complicated, the adjustment of each part is easily accomplished if studied and will produce a definite effect quickly learned. For instance, too high an injection air pressure will cause a cylinder knock because the fuel is all blown in at once instead of being fed in across the top of the indicator diagram. This is regulated, as a rule, by a suction gate valve on the compressor. A sticking injection valve causes one kind of trouble, and a burned exhaust valve another, or a leaky piston ring still another—all are easily recognized and remedied.

During a trip it is customary to overhaul all auxiliary machinery, spare valves and spare parts. In port the main bearings and pins are gone over, and spare valves exchanged for burned or dirty valves.

During a trip kerosene (paraffin) is used freely to clean valve stems and guides. Pure kerosene (paraffin) is fed to the engine for a few minutes each day to clear the delicate injection valve of tar or carbon.

A filtering system is usually provided for the lubricating oil. The system includes cooling coils and settling tanks. The cylinders are usually lubricated separately with pump drips. A special, fine adjustment is provided for each stage of the air compressor. It is important that none of the air compressors has an excess of lubricating oil. In the first place it is liable to explode in the compressor and wreck the compressor, although recent designs are made to stand this stress. In the second place, oil drippings or oil mist may accumulate in the air receivers and make an explosion possible. Certain electrical or chemical actions not fully understood cause combustion under these conditions, with serious results.

Drains Must Be Watched

It is important to inspect and drain water from day tanks, water and oil from maneuvering air tanks, injection air tanks, receivers and intercoolers on each stage of all air compressors, and oil filter tanks. These should be drained systematically and entered in the log.

When a Diesel engine, either main or auxiliary, is stopped, the circulating pump should be kept running until the heads are quite cool; otherwise hot water and steam will collect in the heads, baking the salt on the jacket side and baking the lubricating oil on the other side. Furthermore, if the heads happen to dry out and become hot and then the pump is again started, the cold water is quite apt to crack the heads.

Thermometers or pyrometers are usually provided in the exhaust pipes, principally to show if one engine is running hotter than others. If so, it is considered a pretty good sign that that engine is doing more than the others, and a slight adjustment is made on the oil.

It is extremely important to keep water out of the lubricating oil. Non-saponifying oils are used for the cylinders, and it is considered good practice to use the same oil in the circulating system, and thus carry only one stock of oil.

It has not been intended in this article to instruct in the operation of the Diesel, for that cannot be done in writing,

Reinforced Concrete Cargo Vessel Driven by Hot Bulb Crude Oil Engines

but merely to draw a little picture of operating conditions for the benefit of steam engineers. Diesel operation should not be judged by a few miserable, underpowered sailing ships equipped with cheap engines or with the experiments of various inventors. This article refers to the one hundred or more ships with years of successful operation to their credit, and equipped with upwards of two thousand horsepower each. Such ships, we regret to say, fly foreign flags exclusively. We are, however, entering slowly upon an era of motorships, but it is against much protest in high places.

All other countries are committed to huge motorship programmes, in spite of the fact that we are the producers of one-third of the world's supply of petroleum. The Diesel engine will eventually supplant other forms of marine propulsion because it has behind it natural laws which cannot be gainsaid by propaganda, prejudice or inertia. Successful engines are now available, and there is no record of failure or displacement of modern, conservative, slow-speed, well-known Diesel engines.

It is not the saving in cost of fuel where the Diesels primarily win out, although they use one-third the fuel of a steam engine of triple-expansion type, but in the fact that ships equipped with this system of propulsion carry from ten to thirty percent more freight with half the crew and less insurance.

A Successful Motor-Driven Concrete Tramp

One of the essential factors in the war against prevailing high prices must be the reduction of freight rates. This calls for cheaper boats and cheaper motive power.

In regard to cheaper vessels, the reinforced concrete construction may be considered a success and past the experimental stage. The same may be said relative to cheaper power as represented by some well-known hot bulb crude oil engines. A combination of these two would, therefore, mean a considerable advance in the desired direction.

Following is an abstract from the log book of the Norwegian-built concrete ship *Askelad* (170 feet by 31 feet, of 1,000 tons deadweight). This boat is equipped with two 2-cylinder Bolinder crude oil engines, each of 160 horsepower. The abstract of the log needs no comment and serves to show the good features of the boat, as well as the precision, reliability and low running cost of the engine:

"Left Kristiania December 11, 1918. Arrived Rouen December 23, 1918. Total running time of engine 182 hours. The ship was at anchor several nights because of the danger of mines. The port engine stopped twice, each time five minutes, to change air valve springs. Starboard engine stopped once for the same reason. Kerosene (due to the fact that no other oil was obtainable in Norway) was used and the consumption was 154 pounds per hour. The lubricating oil consumption was 6½ pounds per hour. The average speed of the engines was 220 revolutions per minute.

"Left Rouen January 6, 1919, in ballast. Arrived London February 7, 1919. Total running time of engines 60 hours. The ship laid in Havre ten days, went on shore and remained for sixteen days, but was taken off by own power. The engines were running perfectly.

"Left London March 7, 1919. Arrived Grimsby March 9, 1919. The running time of engine 32 hours without any stop. The kerosene consumption was 132 pounds per hour. Lubricating oil consumption 6 pounds per hour. The average speed of engines 225 revolutions per minute.

"The ship left Grimsby after repairing damages due to the stranding on March 9, 1919, but the sea was too rough and they had to let go the anchors. When one anchor chain broke the engines were started in case of emergency and were running for forty hours.

"Left Grimsby April 1, 1919, and arrived at Shields April 2, 1919. Total running time of engines was 20 hours without any stop. Crude oil consumption was 132 pounds per hour. Crude oil was now used for fuel. The lubricating oil consumption was six pounds per hour. The average speed of engines 225 revolutions per minute.

"Left Shields April 4, 1919. Arrived Calais April 7, 1919. The running time of engines was 48 hours without any stop. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 6 pounds per hour. The average speed of the engines 220 revolutions per minute.

"Left Calais April 12, 1919. Arrived Kings Lynn April 17, 1919, via Yarmouth. Actual running time of engine 31 hours without any stop. Crude oil consumption 132 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. The average speed of engine 225 revolutions per minute.

"Left Kings Lynn April 27, 1919. Arrived Rotterdam April 30, 1919. Actual running time 60 hours without any stop.

"Left Rotterdam May 5, 1919. Arrived Shields May 7, 1919. Actual running time of engines 39 hours without any stop. Crude oil consumption 132 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engines 225 revolutions per minute.

"Left Shields May 10, 1919. Arrived Kristiansand May 12, 1919. Continued the trip to Fredriskshald May 13, 1919. Arrived May 15, 1919. Actual running time of engines 79 hours without any stop. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engine 220 revolutions per minute.

"Left Fredrikshald May 19, 1919, in ballast. Arrived Drammen the same day. Actual running time of engine 9 hours without any stop.

"Left Drammen May 24, 1919. Arrived London May 29, 1919. Actual running time of engine 125 hours without any stop. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engine 220 revolutions per minute.

"Left London June 6, 1919. Arrived Methill June 8, 1919. Actual running time of engines 53 hours without stop. Crude oil consumption 132 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engines 225 revolutions per minute.

"Left Methill June 20, 1919. Arrived Fredrikshaven June 23, 1919. Actual running time of engines 74 hours. Starboard engine stopped once for changing of air valve springs; could be started without reheating. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engines 220 revolutions per minute.

"Left Fredrikshaven June 27, 1919, in ballast. Arrived Gothenburg the same day. Actual running time of engine 7 hours. Crude oil consumption 132 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engines 225 revolutions per minute.

"Left Gothenburg July 9, 1919, for London. Actual running time of engines 155 hours without any stop. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engine 220 revolutions per minute.

"Left London July 24, 1919, in ballast. Arrived Methill July 27, 1919. Actual running time of engines 171 hours. Port engine stopped twice because of air in fuel suction line. Starboard engine stopped once for changing air valve springs. At each stop the engines could be restarted without reheating. Crude oil consumption 132-143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engines 200 to 225 revolutions per minute.

"The reason for the speed difference was a high sea and head wind.

"Left Methill July 30, 1919. Arrived Kristiania August 4, 1919, via Kristiansand. Actual running time of engines 93 hours. The starboard engine stopped once for exchange of two air valve springs. Port engine stopped once for cleaning the injection nozzle. In each occasion the engines could be restarted without reheating. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engine 220 revolutions per minute."

Summary of Engineers' Log Book Covering the First Eight Months' Operation

The starboard engine was stopped four times for replacing air valve springs.

The port engine was stopped twice for replacing air valve springs and twice for air in the suction line and once for cleaning out a fuel injection nozzle.

In each case, however, the repairs did not take more time than that the engine could be started again without reheating the hot bulb, i. e., a few minutes.

Total running time, 1,238 hours.

Average fuel consumption, 137.5 pounds per hour for the eight months of operation.

Total price of fuel oil for 1,238 hours, if bought in this country, $1,111.59 on a basis of 45 cents per gallon.

The fuel bill for a steam engine would, during the same period, have been $2,475, estimated on the basis of 2.5 pounds of coal per brake horsepower per hour.

The cost for repair parts during the eight months was $2.70, namely, six air valve springs at 45 cents each.

Early Transatlantic Steamers

BY F. B. C. BRADLEE

The recent celebration of the centenary of transatlantic steam navigation calls to mind two very early steamers that crossed the Atlantic and which seem to have been overlooked, or forgotten, by the historians.

The first of these was the *Beaver*, a small craft owned by the Hudson's Bay Company; she was built of wood in 1835 by Green and Sons, London, measuring 187 tons gross, 101 feet long and 20 feet beam; her machinery (probably of the side-lever type) is quoted as of "70 nominal horsepower."

The *Beaver* was sent out from England to British Columbia in 1835, it is said, under her own steam. If, as there seems to be no doubt, this is so, why is not this little steamer the pioneer to cross *from Europe* instead of the *Great Western* and *Sirius*, whose first voyages were not made until 1838?

The *Beaver* was also the first steamer in the Pacific Coast, where she remained in active service until 1888, when she was wrecked near Vancouver, B. C.

Another early transatlantic steamer was the *City of Kingston*. She also was built at London in 1837 and was intended for a packet between Jamaica and Carthagena. She left London for her destination, calling at Madeira, early in 1838—certainly before the *Sirius* and *Great Western* made their voyages.

On the run from Plymouth to Madeira she was seven days, five of which were under steam. Failing to find the expected business as a packet, the *City of Kingston* left Jamaica about the middle of March for New York, but was obliged to put in at Norfolk, Va.

Here she remained several days and then started again, but on March 31 she met with a gale and was unable to make steam with either anthracite coal or wood, so put back and went to Baltimore.

She left Baltimore on May 27, 1838, for London direct, commanded by Captain Crane and having 300 tons of coal on board, which was sufficient for her to steam all the way on the passage across. As some authors have gone so far as to say that the *City of Kingston* was a myth, the following quotations from the *New York Shipping and Commercial List* will definitely clear the matter up: "March 17, 1837, under Norfolk, Va., arrivals: 'Br. steamer *City of Kingston*, Gibbs, Kingston, Jamaica.'" "May 23, 1838, under Baltimore, Md., cleared: 'Br. steamer *City of Kingston*, Crane, London.'"

Fig. 1.—The *Beaver*, First Steamer on the Pacific; wrecked at Vancouver, B. C., 1888

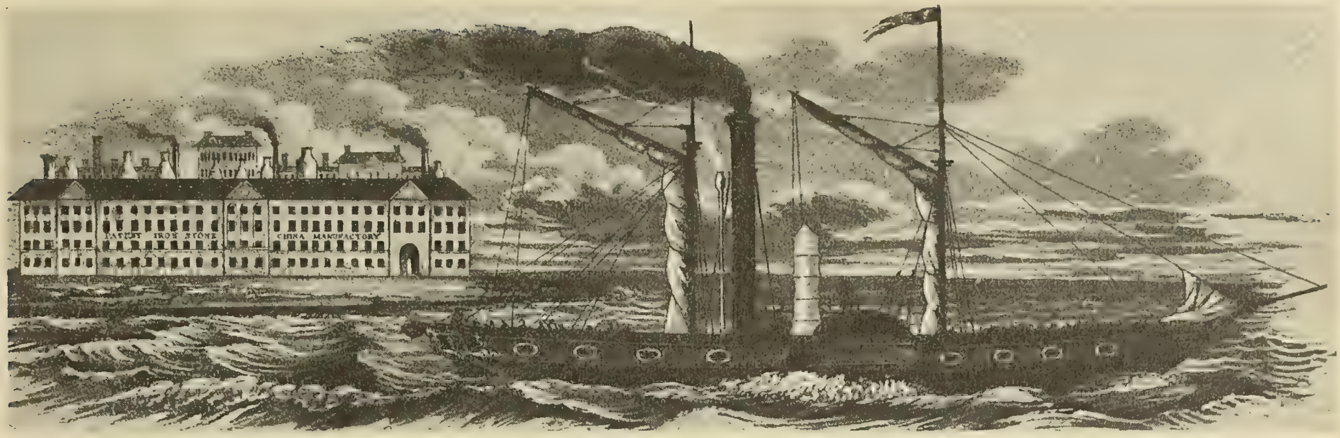


Fig. 2.—The *City of Kingston* (that crossed the Atlantic in 1838) in Her Later Days as a Cross-Channel Packet

The *City of Kingston* measured 325 tons. She was schooner-rigged and, besides, carried a large square sail on the foremast. Her construction is described as "long and buoyant."

The machinery consisted of two low-pressure engines (probably of the side-lever type), each of 50 nominal horsepower. The cylinders were 40 inches in diameter, with 4 feet 4 inches stroke. There were two boilers, consuming one-half ton of coal every hour.

It is believed the *City of Kingston* finished her days in the cross-channel service between Southampton and Havre.

New Method of Joining Ship Sections

BY JAMES NACY*

WHEN it became necessary to utilize the shipyards along the shores of the Great Lakes for building ocean-going vessels of great tonnage, various methods of sectional construction were developed to permit the passage of the ships through the canal locks on their way to the Atlantic. One such method has been designed with the object of eliminating the use of a dry dock in assembling the several sections.

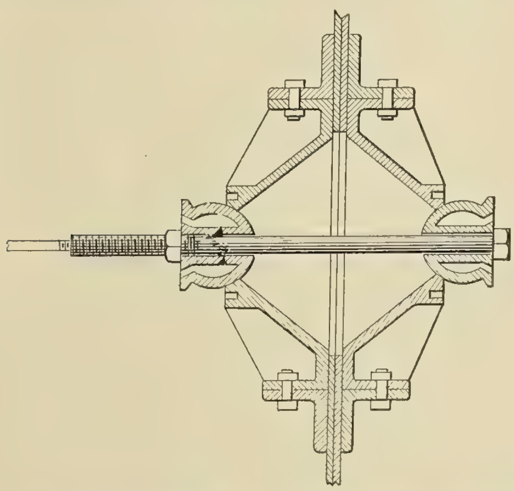


Fig. 1.—Ball and Socket Bolts to Facilitate the Alinement of Ship Sections Being Joined

The idea is to render each section a seaworthy unit by closing the ends with special watertight bulkheads and to arrange pipe connections in each section so that the usual trouble of pipe fitting after assembly is avoided. A vessel may be launched in sections and assembled after passing through the locks, or it may be launched as a unit and disassembled when necessary.

Features of the Construction

The method of construction is essentially to provide each section of the ship with an athwartship bulkhead, forming a vertical end wall, smooth on the outer side. On the inboard side this bulkhead is connected with the decks and braced so that the section may be navigated successfully. When separated, bolt and rivet holes in the bulkheads are closed.

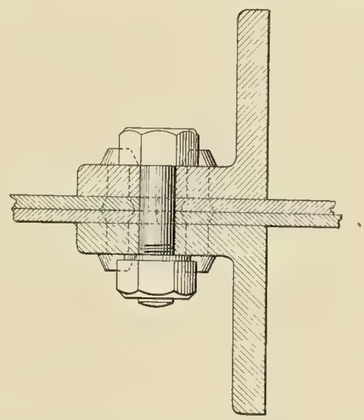


Fig. 2.—Method of Bolting Bulkhead Stiffeners

In joining the parts of the ship a heavy canvas jacket is carried around the connection and strapped to the rails on either side to prevent water interfering with the work. When the sections are first abutted a row of bolts or rivets along the waterline is fastened through the bulkheads; then if not in proper alinement the trim of the sections may be obtained to make correct adjustment possible. Bolts and rivets are then fitted across the deck angle and down each side to the center keelson.

May Be Applied to Regular Hull Design

The hardest operation is to bring the sections in accurate alinement, and for this purpose long bolts, having ball and socket seats, are fitted through the bulkheads. The pads for the sockets have a decided flare, so that the bolts are permitted to pass through at quite an angle. Spherical collars insure the proper heading of the bolts. When the bolts and collars are in place the nuts are turned up so that the sections are accurately drawn together.

No special hull design other than the bulkheads at the

* Marine architect, surveyor, etc., Milwaukee, Wis.

end of the sections is necessary. Bulkhead plates are strengthened by triangular braces riveted to the upper or under side of the deck, as the case may be. Riveted angle bars complete the fastening of these braces to the deck. Vertical stiffeners are provided not only at the abutting edges of the adjacent bulkhead plates, but also at the vertical center of these plates. The method of bolting stiffeners through the bulkhead is indicated in Fig. 2. Between the shell bottom and tank top the structure is braced and the plate closed by a construction similar to that above the tank top. Girders are provided which extend intermedially fore and aft to brace the bottom structure. Between decks short stringers are placed to stiffen the bulkheads and shell at this place. Adjacent to the bulkheads the plates are provided with doublers and angles at the inner edge. Stringers are also connected to the bulkheads by vertical triangular bracing plates.

Every effort has been made to render the transverse end bulkhead thoroughly capable of withstanding moderately heavy weather while proceeding in sections. After the sections are bolted, a heavy angular bosom strap is placed over the end portions of the gunwale angle and extended a sufficient distance each side of the junction to allow a number of bolts to be secured. The upright flange of this strap is also firmly bolted to the sheer strake and sheer doubler. To reduce the amount of fastening to the bulkheads, outside doublers for the deck or shell may be added after the sections are bolted.

The bulkheads are designed to form a permanent part of the vessel and can be made more secure than is ordinarily the case when sections of a ship are joined. They also serve as transverse stiffeners when the vessel is completed.

The invention may be utilized or adapted to ships already built, for the bulkheads may be installed and stiffened as proposed above.

Notes on Connecting Rods

BY JOHN BRENT

When I began my trade a Scotchman put me wise to the value of keeping notes on what I did and what I saw. For a long time I found that after making notes it was a very troublesome matter to find the notes again. At last I was shown that by the use of filing cards I could index my notes.

I used these cards for taking down anything of interest, making but one entry on each card unless I had two things to jot down on the same subject, then I made two notes on the same card. I transferred these index cards to a loose-leaf book, placing them under the letter of the index to which they belonged, but at times it was difficult to know just what heading was best.

Under the heading "Connecting Rods" I found the other day a few items which I think might interest the readers of MARINE ENGINEERING.

In an Austrian ship I saw a forked end connecting rod fitted with an adjustment for each of the crosshead pin bearings, and that was something new to me.

The top end of the rod was finished in the usual way, but the lower half of the brasses were finished quite differently. Instead of the brasses finishing flush with the tops they overhung about one-quarter of an inch. The lower face of the brass was cut out so that the overhang came down over the rod and was not straight between these edges but tapered. Between the brasses and into this recess a steel wedge was fitted through which the bolts passed, but the holes in the wedge were elongated athwartship. This allowed for adjustment of the wedge.

The amount of possible adjustment was small—not over three thirty-seconds of an inch—but it is clear that by this construction either side of the connecting rod brasses could be very nicely brought to a bearing.

On the lower end of the rod on an Italian ship I saw this construction: The top half of the crank pin brass and the lower end of the rod were hinged athwartship, so that the brass was "flexible," so to speak. The design was not as clumsy as one might think, and I was told by the engineer in charge that until the hinged system was put on the crank pin brasses gave great trouble by heating.

Over on the French coast I saw a torpedo boat built by Normand, and the lower end of the connecting rods on this boat made me stare. Standing in front of the engine the lower ends of the rods were thinned down, just above the foot to about half an inch in thickness for 4 inches up. Looking at the rods from the inboard end of the engine the thinned portions of the rods were bulged out athwartship so that they looked like the ace of hearts.

The amount of metal in these bulged parts was just equal to the amount of metal that would have been in the rods if they had not been thinned down. The idea was to allow a little spring in the rods for self-adjustment of the brasses, and I was told that they worked very well.

Down below Atlantic City I saw two or three little steam launches fitted with compound engines and the thrust bearings in these boats were unusual. Instead of the horseshoe collar fitted between collars turned on the shaft having parallel faces, the shaft collars were turned with faces set at a slight angle to the center of the shaft, making a cross-section very much like an Acme thread. Instead of one horseshoe for each collar, two were fitted, the top one being drilled free for bolts that entered tapped holes in the lower horseshoes. This allowed the two halves to be drawn together so as to fit the shaft collars nicely, with the result that about twice as much bearing surface was obtained and the adjustment for wear was made very easy. The two horseshoes extended out from the shaft and fitted into slots in the thrust bearing block. This bearing was covered with a plate, keeping out dirt. The thrust block or bearing was filled with oil, and in two years' service no taking up of the collars was found necessary.

One mistake I made in taking notes was not to put a date on the cards. I am now using a typewriter when I copy out my notes, and I find that in so doing I have a very much more satisfactory record.

Trial Trip from Middlesbrough

On December 20, 1919, the S. S. *Cilurnum,* built by Sir Raylton Dixon & Company, Ltd., Middlesbrough, proceeded to sea for her official trials. The steamer is a "C" type standard ship acquired from the Shipping Controller by Messrs. Hall Brothers Steamship Company, Ltd., Newcastle-on-Tyne.

The vessel is of the single-deck type with poop, bridge and forecastle, her principal dimensions being 331 feet by 46 feet 6 inches by 25 feet 6 inches molded. She has been built under special survey to receive British Corporation classification.

The vessel has five holds, five hatches and is fitted with two masts, two derrick posts, ten derricks, six winches and all the latest arrangements for the rapid handling of cargo.

Triple-expansion engines, having cylinders 25 inches, 41 inches and 68 inches diameter by 45 inches stroke, supplied with steam by three large single-ended boilers working at 180 pounds pressure, have been fitted by Messrs. Richardsons, Westgarth & Company, Ltd., Middlesbrough.

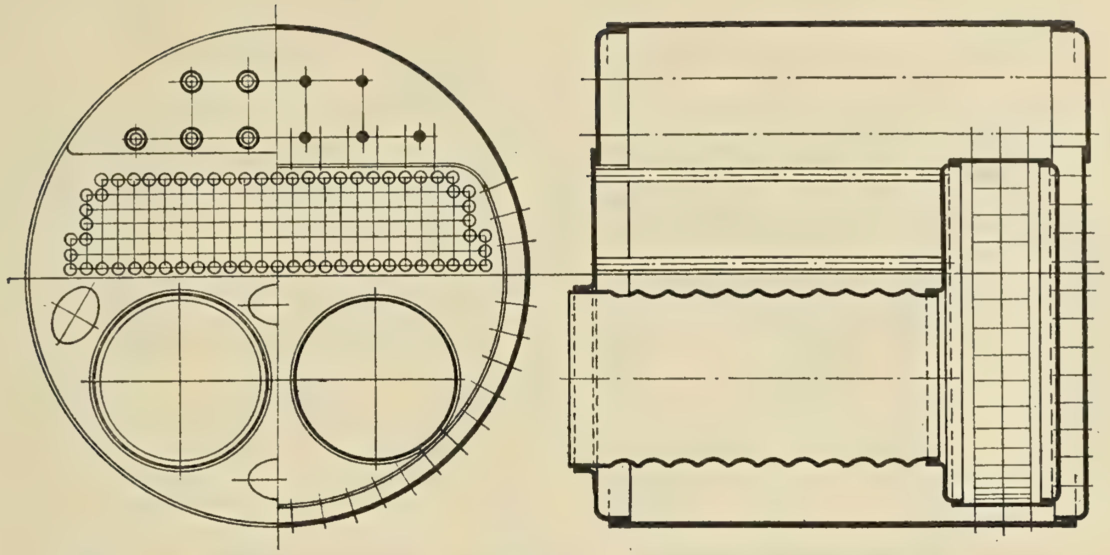


Fig. 1.—Two-Furnace Scotch Boiler, 11 Feet Long and 11 Feet Diameter, Designed by Aid of Charts

Standardization of Scotch Boilers*

The Application of Standardization and Graphical Methods to the Design of Cylindrical Return Tubular Boilers

BY HENRY C. E. MEYER

As this paper is devoted entirely to boilers of the so-called Scotch type, which are subject to faulty design, due to the designer lacking sufficient previous data to build upon, an effort is made to supply data which will enable any designer to plan a boiler which will give good results. It is hoped that the data given may at least be a step in the direction of obtaining more uniformity of design and possibly lead to the adoption of standard designs of boilers.

In order to obtain a successful boiler, two factors of primary importance are more or less dependent, one upon the other. These factors are heating surface and steam space. It would appear that the easiest steaming boiler is not always the one which contains the greatest amount of heating surface, and some very satisfactory boilers have contained only a comparatively small amount of heating surface for their size.

On the other hand, optimism as regards the amount of heating surface that can be crowded into a boiler is one of the primary causes resulting in designs wherein the principal characteristics are not properly balanced, and wherein conditions affecting accessibility, etc., are neglected.

> In Great Britain a committee appointed by the Institution of Naval Architects, North East Coast Institution of Engineers and Shipbuilders, Institution of Shipbuilders and Engineers in Scotland, Liverpool Engineering Society and Institute of Marine Engineers has investigated the extent to which the principle of standardization can be applied to the propelling machinery of vessels. The most important feature of the work carried out by this committee was the development of a standard set of requirements, in so far as the structural strength of the boilers was concerned, which were recommended for adoption by the various authorities which have to do with the inspection and classification of marine boilers. This parallels the work done in this country by the American Society of Mechanical Engineers for stationary boilers when they formulated their "Boiler Code," and is a decided step in the right direction, since the existence of different rules for the same purpose evidently tends to annoyance and confusion, and in many cases imposes a handicap on the builders.

We cannot sacrifice steam space indefinitely, nor can a boiler that is inaccessible have a long or satisfactory life. Steam space is undoubtedly one of the primary requisites to the proper performance of boilers, and it would appear that for ocean-going vessels an average practice is to keep the center of the upper row of tubes at one-sixth of the diameter of the boiler above the center-line, whereas for coastwise or harbor vessels this distance is approximately one-fifth of the diameter, and these proportions have been rigidly adhered to in preparing the data for this paper.

Only two types of Scotch boilers have been considered, i. e., those with separate combustion chambers and those with a common combustion chamber, and while there are other variations they are not by any means common. The separate combustion chamber type is more particularly suitable for ocean-going service, whereas the common combustion chamber type is used principally for coastwise and tugboat service. When forced draft is used the separate combustion chamber becomes almost essential.

Perhaps one of the best reasons for adhering to the

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1919.

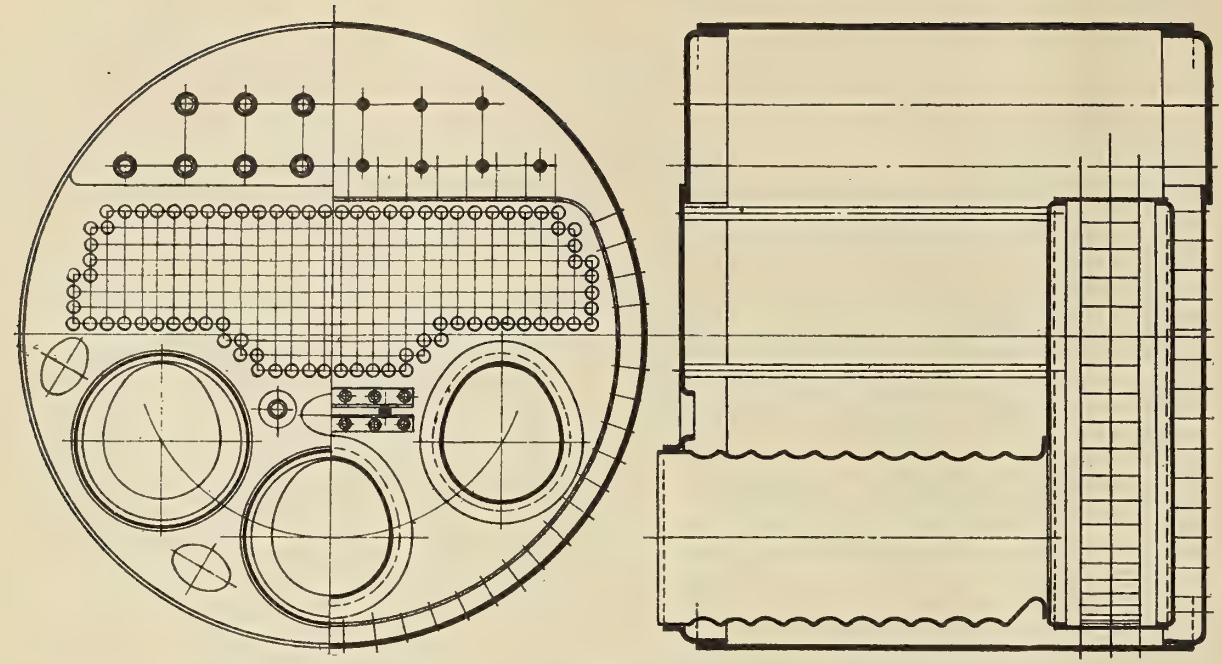


Fig. 2.—Three-Furnace Boiler, 13 Feet Diameter and 11 Feet Long. Heating Surface, 2,050 Square Feet; Grate Area, 60 Square Feet

separate combustion chamber type of boiler for ocean-going vessels lies in the fact that the interior of this type of boiler is so readily accessible for cleaning purposes, and there can be no doubt that a boiler which is examined and thoroughly cleaned at regular intervals is going to give the best service and have the longest life.

It is not the intention to discuss in this paper the methods for arriving at the heating and grate surface required to develop a given power, but rather to determine upon the dimensions of a boiler to give a predetermined heating surface. While the determination of the heating and grate surface required ought to be based upon actual steam consumption, it is to be regretted that there exists very little published data, determined by actual trial, as to the real consumption of steam by different types of marine propelling machinery, or as to the actual evaporation of water by boilers of the type under consideration.

On the other hand, there are so many successful vessels in operation to-day that the determination of the heating and grate surface is fairly simple, even though methods are used which are perhaps not quite as scientific as they might be; and, while the possession of more accurate data might enable the designer more closely to approximate his requirements with the actual performance of the boilers, in merchant vessels reasonable excess of boiler power can never be considered a fault.

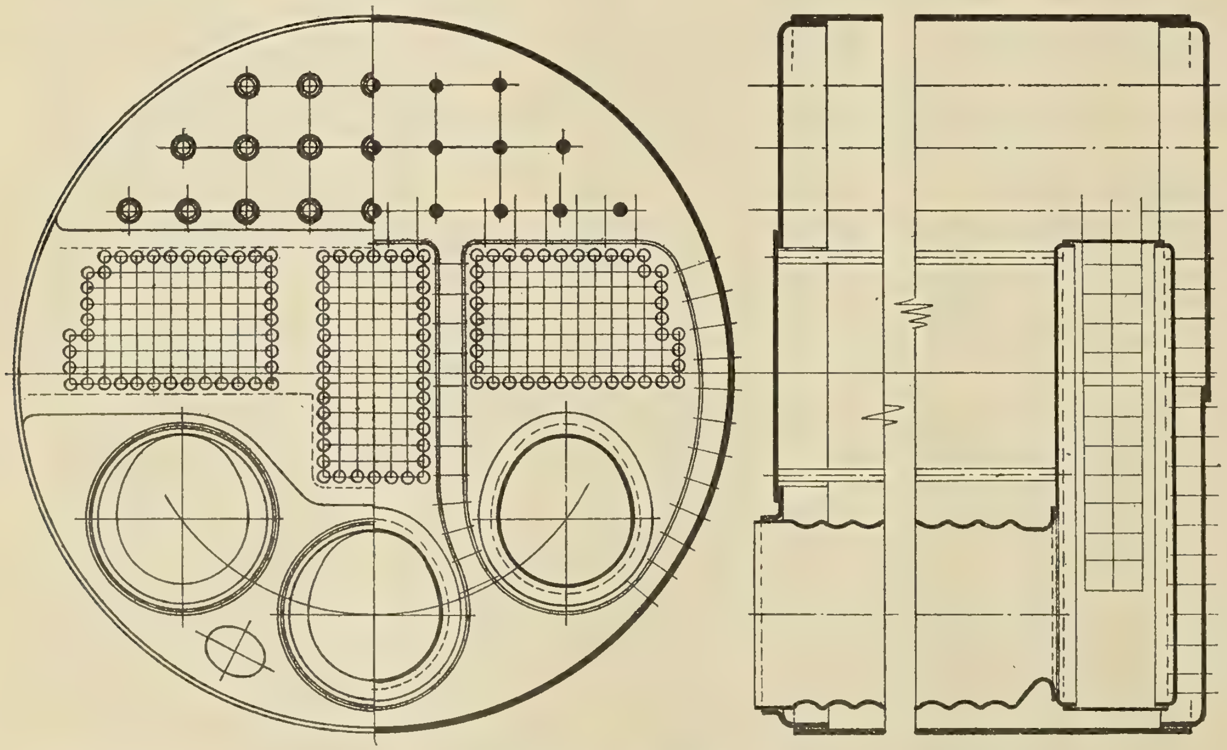


Fig. 3.—Three-Furnace Boiler, 15 feet Diameter and 11 Feet Long. Heating Surface, 2,288 Square Feet; Grate Area, 67.5 Square Feet

The life of a boiler constantly forced to the limit is bound to be shorter than that of a boiler which readily keeps the machinery supplied with steam at a constant pressure, and it would also appear that, where fires are forced, the losses due to imperfect combustion would be greater.

Another very probable cause for the failure of boilers to steam properly lies in the fact that if the designer is limited to diameter of boiler he is apt to overestimate the amount of heating surface that can be placed in a boiler of a given size; and, while there is no doubt that the heating surface which is contained in most boilers could be considerably increased by reducing the available steam space or by crowding the tubes, it is very much to be doubted whether the boilers would be improved thereby.

The writer has come across cases where the heating surface has been increased by keeping the tubes very close to the furnaces; and, while the calculated heating surface was thereby increased, it is quite possible that the elimination of all the tubes which were in close proximity to the furnaces would not have had any appreciable effect on the steaming qualities of the boiler.

One of the causes of the great differences existing in designs lies in the fact that prior to the war, when the individual shipyards of this country were engaged on many different types of vessels at the same time, ranging from ferryboats to big passenger liners, the conditions were not favorable to the development of standard designs. A design for a 10-foot diameter boiler might be followed by another for a 15-foot boiler, and this again by a design for a 13-foot boiler. Each case being developed upon its own merits, it was to be expected that regular progression of the various proportions of different boilers would be given but scant consideration, with the result that in some cases boilers of varying diameters had the same heating surface and diameter of furnace.

With this condition in mind, the writer at one time made a series of designs progressing at the rate of 3 inches in diameter of boiler, which designs proved that a regular progression of dimensions could be maintained and that the resultant designs would have well-balanced proportions.

The designs referred to were limited to boilers with separate combustion chambers for forced draft, and boilers with common combustion chambers for natural draft, all with three or four furnaces, but did not cover two-furnace boilers.

In the accompanying diagrams boilers with separate combustion chambers for natural draft have also been included, and the diagrams for boilers with common combustion chambers have been extended to include two-furnace boilers. While some two-furnace boilers are fitted with separate combustion chambers, these boilers generally are small, as in the case of small vessels for coastwise or harbor service or of donkey boilers, and it would seem that a common combustion chamber type would be equally acceptable in such cases and would be considerably cheaper to construct.

Furnaces

The diameter of furnace that can be used conveniently in a boiler of a given size is a question that may be open to considerable discussion. It is, however, one of the first and most important features of design, since a furnace too large will result in either unduly crowding the tubes and reducing the steam space available or having an insufficient amount of heating surface and area through tubes, whereas a furnace too small in diameter will result in poor combustion and insufficient grate surface.

In determining upon a standard design, therefore, the diameter of the furnace should be a prime factor, and Fig. 4 gives furnace diameters which not only are in accord with average practice but which increase systematically in proportion to the diameter of the boiler.

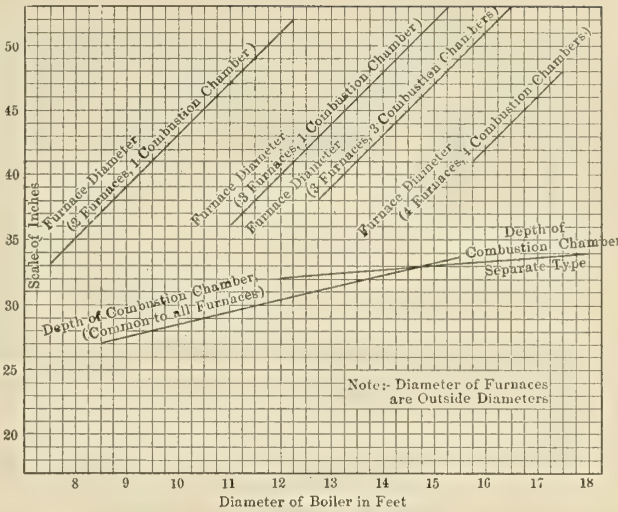


Fig. 4.—Diagram for Diameter of Furnace and Depth of Combustion Chamber

Attention is again drawn to the fact that there seems to be considerable difference of opinion on this subject, some builders using smaller, others larger furnaces, but the dimensions given will ensure a well-balanced design when all the other features have been taken into account, such as the ratios between heating and grate surface and between area through tubes and grate surface.

It should be remembered that in Fig. 4 the diameters of furnaces given are the extreme outside diameters and not the effective diameters.

Tubes

While there are many different sizes of tubes used, the most common practice seems to be to use 3-inch outside diameter tubes for natural and 2½-inch outside diameter tubes for forced draft.

It is evident that by the use of smaller tubes the heating surface in a boiler can be increased, but there seems to be no really sound reason why in a series of standard designs of boilers the above diameters could not be adhered to.

Fig. 5 gives the number of tubes for each size of boiler.

At this point it is well to note that the number of tubes which can be placed in boilers of a standard type and with standard characteristics will not give quite as regular a curve as plotted on the above diagrams.

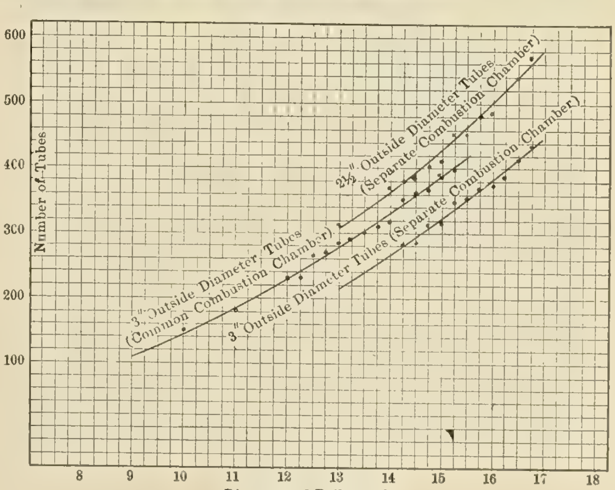


Fig. 5.—Diagram for Number of Tubes

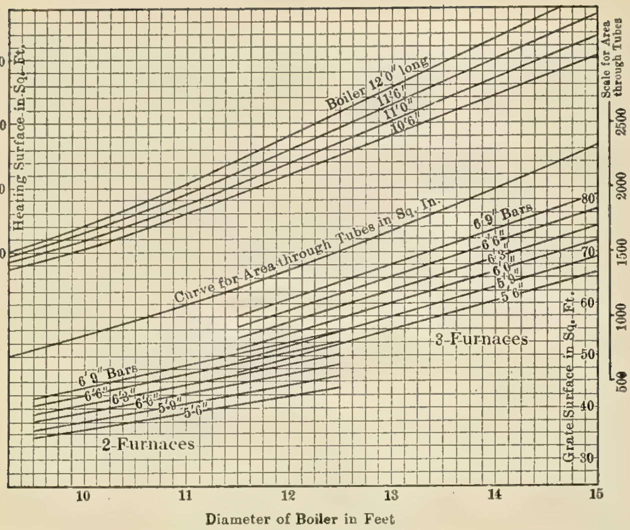


Fig. 6.—Diagram for Heating and Grate Surface and Area Through Tubes for Cylindrical Return Tubular Boilers, Common Combustion Chamber Type. 3-Inch Outside Diameter Tubes

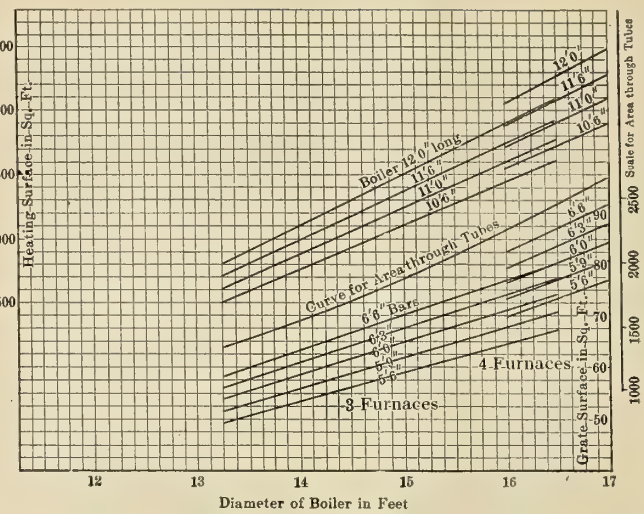


Fig. 7.—Diagram for Heating and Grate Surface and Area Through Tubes for Cylindrical Return Tubular Boilers, Separate Combustion Chamber Type. 3-Inch Outside Diameter Tubes

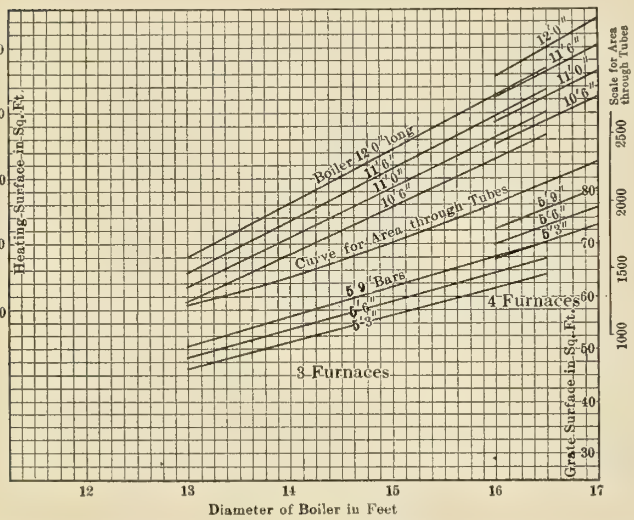


Fig. 8.—Diagram for Heating and Grate Surface and Area Through Tubes for Cylindrical Return Tubular Boilers, Separate Combustion Chamber Type. $2\frac{1}{2}$-Inch Outside Diameter Tubes

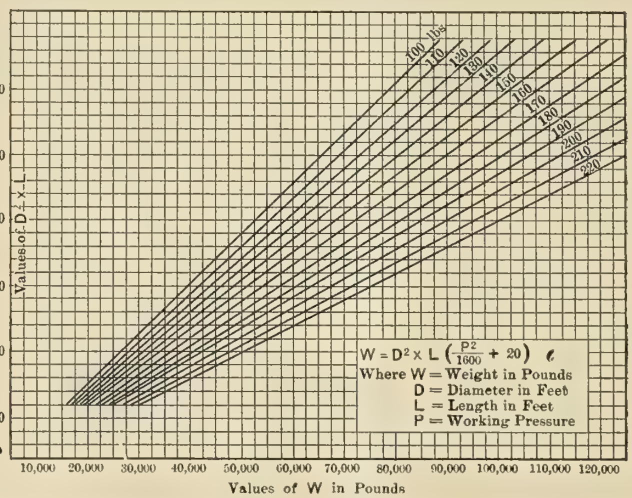


Fig. 9.—Diagram for Weight of Material of Cylindrical Return Tubular Marine Boilers. Common Combustion Chamber Type. Weight Given in Pounds

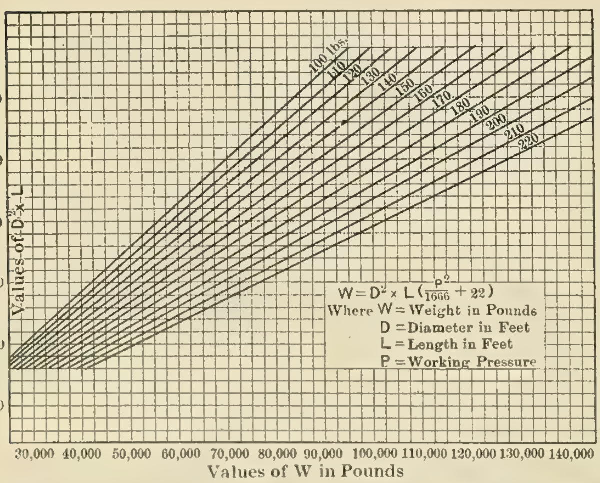


Fig. 10.—Diagram for Weight of Material of Cylindrical Return Tubular Marine Boilers. Separate Combustion Chamber Type

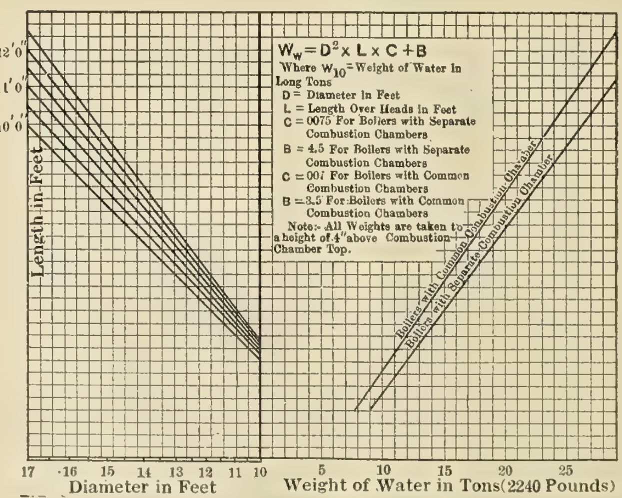


Fig. 11.—Diagram for Determining Weight of Water in Cylindrical Return Tubular Marine Boilers

The spots indicated on the diagrams give the actual number in the case of some standard designs actually worked out, and it will be noted that at various points a step occurs in the curve. This step is due to the fact that when the point is reached where, due to the increase in size of the boiler, it becomes possible to add another

horizontal row of tubes, the number of tubes is increased somewhat rapidly.

As regards the length of the tubes, this is of course dependent upon the length of the boiler, depth of combustion chamber and depth of water space back of the combustion chamber.

It would appear that by definitely settling upon certain desired characteristics of boilers, i.e., the ratio of heating to grate surface and the ratio of area through tubes to grate surface, the lengths of a complete series of boilers could be kept down to very few different dimensions, which would result in the possibility of keeping the tubes of certain standard lengths, possibly only three or four lengths being required, which would enable both the manufacturers and boiler makers to keep stocks of tubes for ready use.

It would also have the further advantage that the lengths of furnace could be kept standard, and there is no reason why these should not be made to standard dimensions throughout, which again would make possible the standardization of furnace fittings.

Anyone familiar with repair shop practice knows that unless each vessel is provided with patterns for the side bars for each furnace, whenever it becomes necessary to renew same, new patterns have to be made and fitted to each furnace, which in itself constitutes a serious economic waste.

Lastly, the boiler maker would be benefited by the fact that all longitudinal stays could be made of standard dimensions.

Combustion Chambers

The depth of combustion chambers used in connection with these diagrams has been plotted on Fig. 4. The proportions given are quite sufficient for coal burning and generally should be sufficient when burning oil, although some designers prefer to use a greater depth in the latter case.

It should be kept in mind that the dimensions given are inside dimensions, and the actual depth used should be stated in even inches, which will somewhat simplify the calculations for allowable pressures on plates, stays and girders, etc.

Heating and Grate Surface

Based upon the dimensions for furnaces and combustion chambers given by Fig. 4 and upon the numbers of tubes given by Fig. 5, the diagrams for heating surface, grate surface and area through tubes have been constructed.

By reference to Figs. 6, 7 and 8 it is possible to quickly estimate how much heating surface may be expected from a boiler of certain dimensions or, knowing the heating surface required, what size boiler is needed. In this connection the writer would again point to the comparative scarcity of published data on the performance and efficiency of Scotch boilers.

The different authorities on the subject give figures for heating surface required that vary widely, and there is no doubt that the tendency to keep the boilers too small is somewhat of a temptation when costs have to be kept down.

After all, the most reliable data for designing boilers are not the result of builders' trials when all conditions are favorable, but rather the average result of actual long voyages of vessels which are no longer new but which have been in operation some time.

There is no doubt but that it might mean some expense to the shipowner to obtain these results, as in many vessels the apparatus for indicating the engines is taken down after the builders' trials and never used again. On the other hand, a careful investigation of the performance of a vessel not giving satisfactory service would probably result in the adverse conditions being eliminated, with consequent advantage to the owners.

As a guide to what can be accomplished, the writer offers the following data taken from actual performance during long voyages of a tramp steamer:

Boilers

Number	Two
Type	Single-end Scotch
Draft	Howden's
Heating surface, total	4,464 square feet
Grate surface, total	104 square feet
$\frac{\text{H. S.}}{\text{G. S.}}$	44

Engines

Cylinders, inches	24-40-67
Stroke, inches	45
Average revolutions	65
Pressure at throttle, pounds per square inch	195
Indicated horsepower	1,600

Auxiliaries

Air pump	Lever-driven
Circulating pump	Lever-driven
Feed pump	Lever-driven
Bilge pumps	Lever-driven
Blower engine	Independent reciprocating
Electric generator	Independent reciprocating
Steering engine	Independent

Consumption of Fuel

Type of coal	Welsh
Coal in 24 hours	24 tons
Indicated horsepower per square foot grate surface	15.4
Coal per indicated horsepower	1.4 pounds
Air pressure at blower	1⅜ inches

The above figures are given as the writer is thoroughly familiar with the particular case and knows that this vessel gave very satisfactory results on voyages of from eighteen to twenty-one days' duration from port to port.

In addition to the diagrams giving the characteristics of designs of a series of boilers, the writer has added diagrams for obtaining the weight of material entering into construction of a boiler and also the weight of water. The weights of materials are gross weights and do not include fittings.

In examining the diagrams it is, of course, impossible for anyone not familiar with the designs whereon same are based to decide at a glance whether these diagrams will give proportions that are reasonable. For this purpose the writer has prepared Figs. 1, 2 and 3, which boilers were designed from data taken direct from the diagrams given. These designs do not present any unusual features, and in preparing them no difficulty was experienced in obtaining the proportions which the charts predicted. The arrangement of tubes was kept as simple as possible in order to avoid unnecessary complication of the smoke boxes, since the few additional tubes that might have been added would only be of doubtful value, anyway.

The diagrams may be used very readily for making a table of standard boilers, and it is to be hoped that the data as given may prove of some benefit to the designer who has not at his disposal a number of designs which have proven to be successful. For the designer who has already a great number of designs available, it may follow that the methods outlined in this paper may be of benefit in co-ordinating his various dimensions of boilers. The following example of the use of the diagrams may possibly demonstrate their value somewhat more clearly:

Let us suppose that it is desired to design a boiler having the following characteristics:

Type	Separate combustion chamber
Heating surface	2,200 square feet
Grate surface = $\frac{H. S.}{34}$	66.3 square feet
Area through tubes not less than	1,800 square inches
Grates not longer than	6 feet 3 inches
Draft	Natural

Since the length of grate bar is fixed, the grate area will be the determining feature as to the diameter of the boiler.

By reference to Fig. 7 it will be seen that bars 6 feet 3 inches long will give a grate surface of 67.5 square feet in the case of a boiler 15 feet diameter, i. e., the diameter of furnaces appropriate to this diameter of boiler is such as to give this amount of grate surface.

The same diagram also shows that if this boiler is made 11 feet long we will have 2,200 square feet of heating surface and an area through the tubes of 1,890 square inches.

The diameter of the furnace can next be obtained from Fig. 4 and is found to be 3 feet 11 inches outside, while the depth of combustion chamber would be 33 inches.

Fig. 5 gives the number of tubes as 320.

Allowing a water space of 9 inches at the back of the combustion chamber and 3 inches for the total thickness of heads, and combustion chamber back and tube sheets, the length of tubes between sheets is 7 feet 3 inches.

The weight of water obtained from Fig. 11 will be 20.6 long tons.

The above results may now be compared with the results actually obtained in the design illustrated by Fig. 3, which results were calculated.

	Estimated	Actual
Diameter	15 feet 0 inches	15 feet 0 inches
Length	11 feet 0 inches	11 feet 0 inches
Diameter of furnaces	3 feet 11 inches	3 feet 11 inches
Number of tubes	320	327
Effective length of tubes	7 feet 3 inches	7 feet 3 inches
Heating surface, square feet	2,220	2,288
Grate surface, square feet	67.5	67.5
Area through tubes	1,890	1,962
Depth of combustion chamber	2 feet 9 inches	2 feet 9 inches
Weight of boiler	102,500 pounds	
Weight of water	23.2 tons	

It will be seen that the design in Fig. 3 closely approximates the desired characteristics and that specifications can be quickly prepared by this method.

Daylight Illumination in the Shops

How the "Daylight Factor" Can be Increased by Devoting Maximum Amount of Wall Space to Glass

In the shipbuilding industry, as in others requiring a high efficiency of the men employed, the problem of lighting the buildings in which the work of fabrication is carried out is an important one.

That natural daylight should be utilized as far as possible in the lighting of buildings was recognized by the engineers of the New York Shipbuilding Corporation, Camden, N. J., who, before construction was commenced on the extensions to the yard, devoted considerable time to the study of various types of window installations to

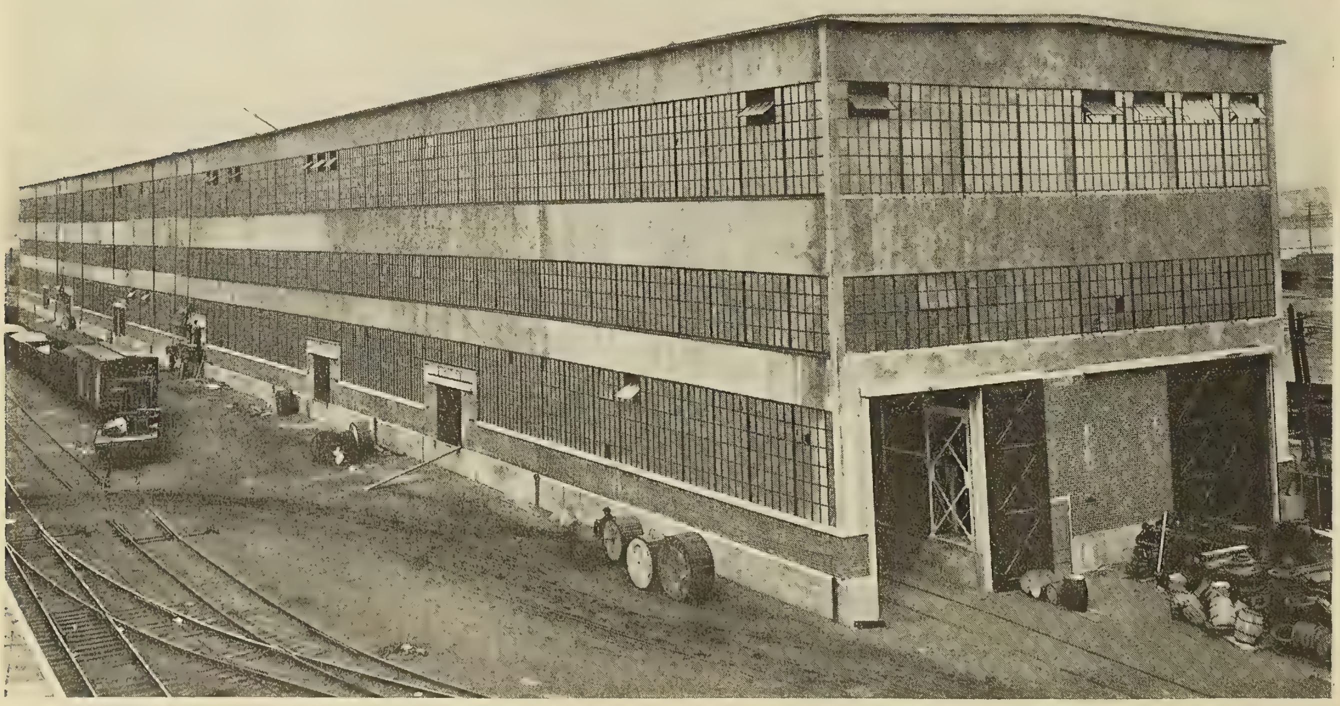


Fig. 1.—Application of Truscon Type Steel Windows to the Freight House of the New York Shipbuilding Corporation

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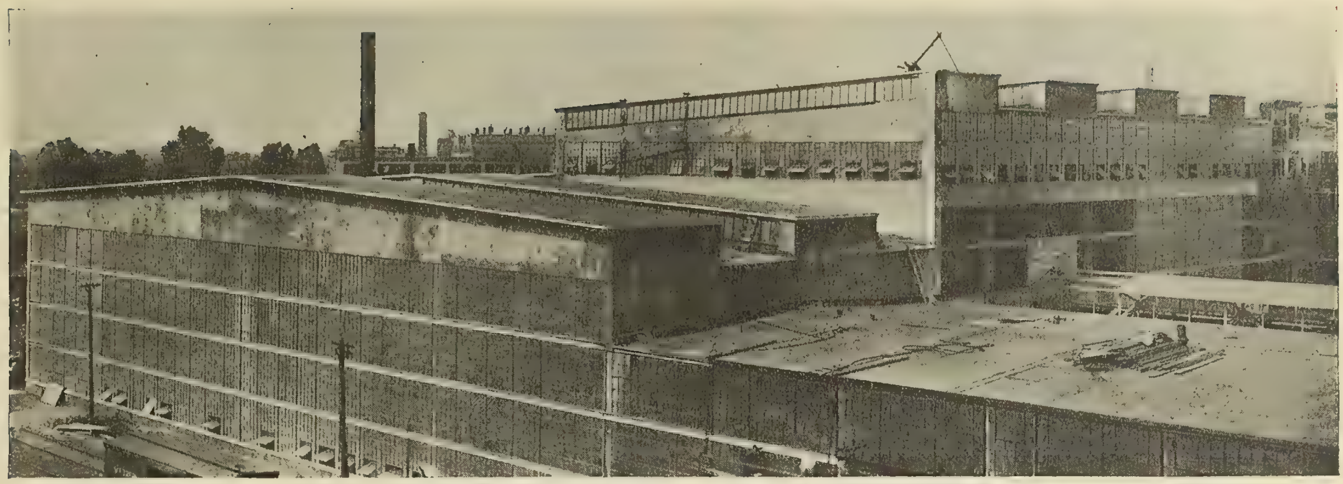


Fig. 2.—All Shops of the New York Shipbuilding Corporation Utilize the Modern Window Lighting Arrangements Exemplified by the Plate and Angle Shop Shown in This Illustration

obtain the maximum lighting effect without artificial means.

As a result of this, they adopted a standard for all their buildings, which consisted of a structural steel framework with a steel sash on practically the entire exterior, the small portion not occupied by the sash walls being filled in with a 2-inch plastered wall on metal lath. The freight house and the plate and angle shop shown in Figs. 1 and 2 respectively illustrate the wide expanse of sash wall used throughout the entire plant.

Lighting Investigations Here and Abroad

The subject of lighting industrial buildings has been very carefully and exhaustively studied by the Illuminating Engineering Society in this country and by the Departmental Committee on Lighting in Factories and Workshops in England, appointed by Parliament. As a result of these investigations the "daylight factor," which is the ratio of the interior to the exterior illumination at some given time of the day and at some given point of the building, taken simultaneously, was determined to be not greater than 0.25 of 1 percent where the buildings were lighted on the sides only. Obviously, with such a small percentage of daylight efficiently used on the interior, it became advisable to utilize the remainder by permitting as large a portion of light to be transmitted into the interior as possible.

The discovery of the inefficiency of ordinary window installations caused the New York Shipbuilding Corporation to use, first, the maximum amount of wall space devoted to windows; second, the maximum amount of window surface devoted to glass, and, third, as little obstruction to the entrance of light as possible.

By the use of structural steel supporting members, instead of bulky and unwieldy brick or masonry, it is possible to obtain the maximum amount of wall space devoted to light. By using steel sash with very narrow muntin bars, and by eliminating heavy jamb sections and weight boxes, the glass proportion of the window is measurably increased. This type of sash is really more economical than wood at the present time, and with the increasing scarcity of lumber is likely to remain so. By using a thin 2-inch metal lath, plastered wall, very little obstruction to the entrance of light is offered.

System Applied to Pier Lighting

The Department of Docks, Wharves and Ferries of the City of Philadelphia has also recognized these principles of construction and has used similar types of construction in many large municipal piers built under its jurisdiction within the last few years. Figs. 3 and 4 show views of one of the recently constructed Philadelphia municipal piers. In pier construction there is not, of course, as great a need for considering the daylight factor as in factory construction; in fact, a very large proportion of the wall space of the lower level of these piers consists of doors, the necessity for which is obvious. The upper deck, however, and the outshore elevations in particular, have a very large expanse of steel, narrow-muntined windows,

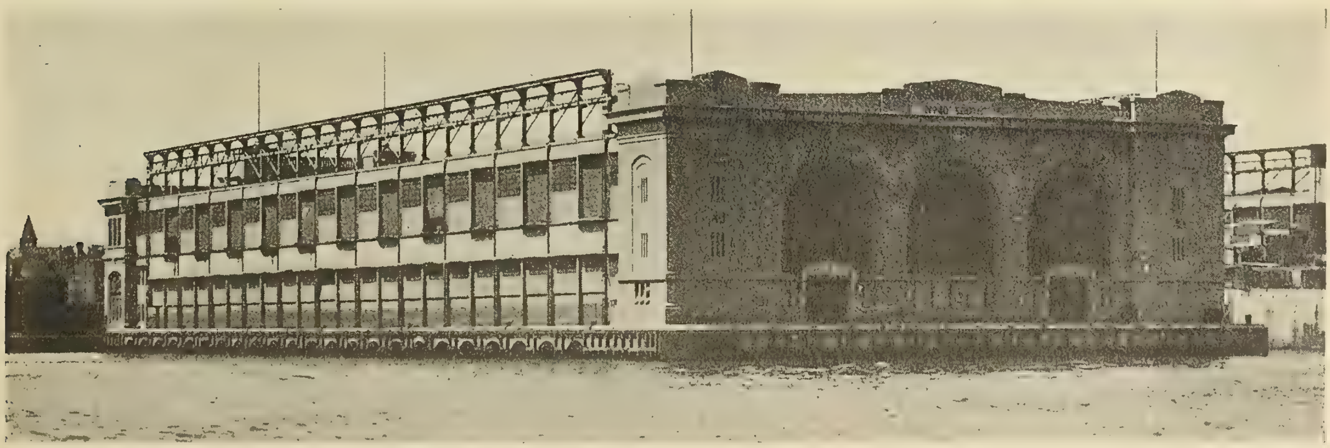


Fig. 3.—In so Far as Practicable, Modern Piers Are Well Provided with Natural Daylight, as Indicated by the Municipal Piers of Philadelphia

Fig. 4.—A Remarkably Good Idea of the Advantages to be Derived from Properly Designed Lighting Facilities May Be Gained from the Interior View of One of the Municipal Piers, Philadelphia

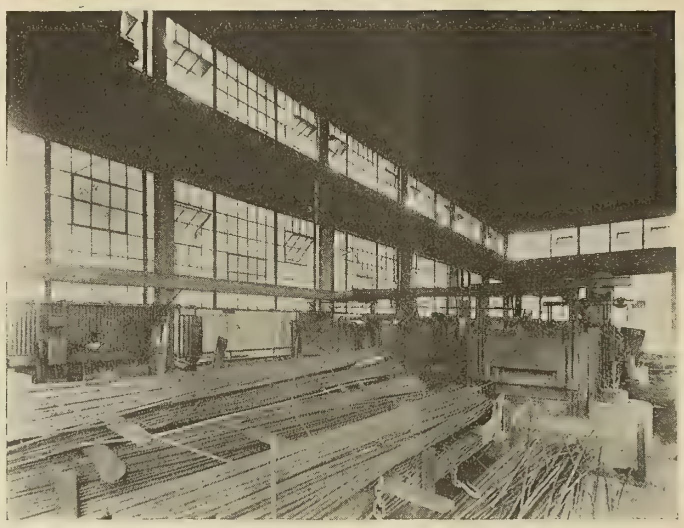


Fig. 6.—A Corner of a Hog Island Shop in Which the Daylight Factor is High

which could not have been as advantageously constructed of wood or other material.

The same type of construction as employed in the shops of the New York Shipbuilding Corporation is used to a limited extent in the buildings of the American International Shipbuilding Corporation at Hog Island, as shown in Figs. 5 and 6, excepting that the percentage of window space is not nearly so large as in the case of the New York Shipbuilding plants. Corrugated iron was used for the non-glass wall material. The corrugated iron is, of course, even thinner than the plastered walls, but it is not nearly as durable and was undoubtedly selected because of the supposedly temporary character of at least part of the Hog Island project.

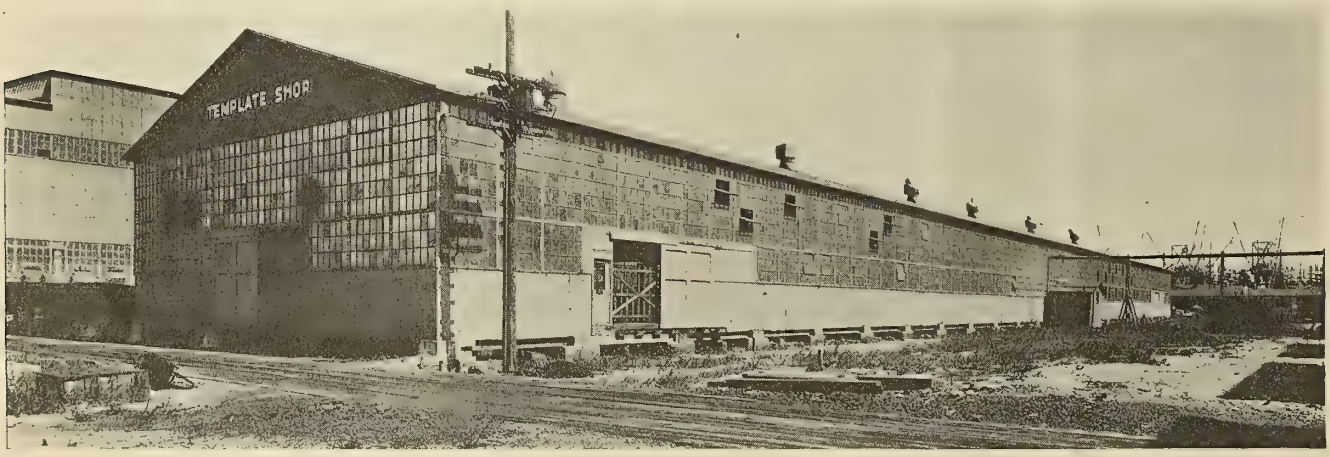


Fig. 5.—Template Shop at the Hog Island Shipbuilding Plant Includes the Window Installations Used to Light the Temporary Structures of This Plant by Natural Means

Steel windows are, of course, no longer an innovation. Their use is more or less standard in the construction of buildings for all industries, but particularly in shipbuilding construction, in pier construction, and, in fact, in all types of construction wherein long buildings are required, has the application of the daylight principle proved of special advantage.

Start to warm up your engine slowly and make the start early enough to get the engine well warmed when you hear the bells to "stand by."

Italian Battleship Dry Docked Upside Down

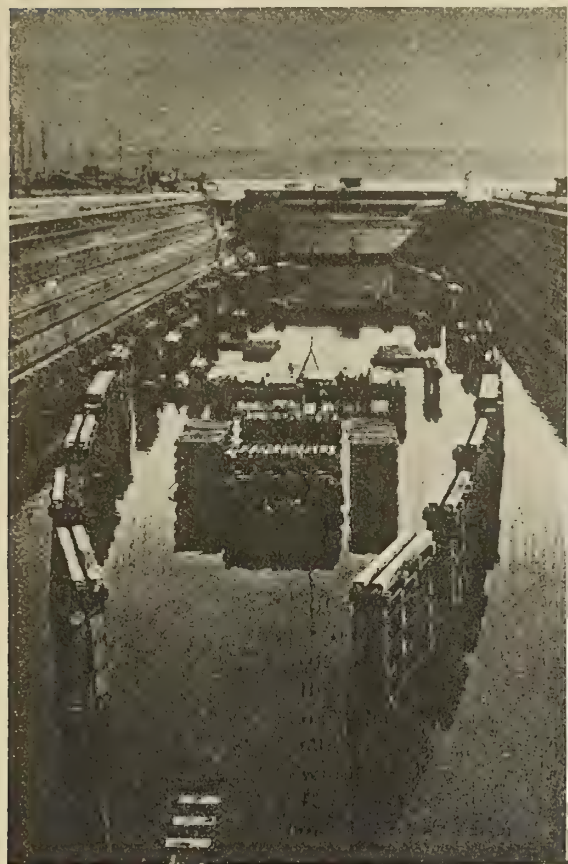
On the opposite page are shown photographs of the Italian battleship *Leonardo da Vinci* dry docked upside down at Taranto after being salvaged and towed into port upside down. The vessel was sunk in thirty-six feet of water in the Piccolo sea on August 2, 1916, by an explosion in the after munition stores.

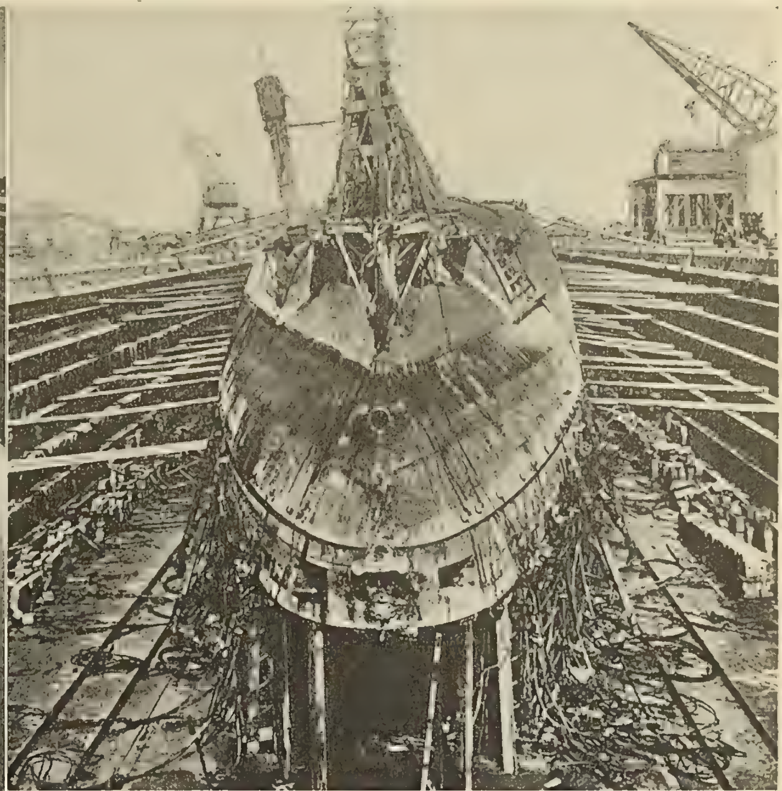
When the explosion occurred the vessel turned turtle and sank in that position. She was refloated by first closing the openings in the hull and then forcing out the water by means of compressed air. She was then towed, still upside down, into the dry dock at Taranto, where the vessel was docked on timber supports arranged as shown in the photographs.

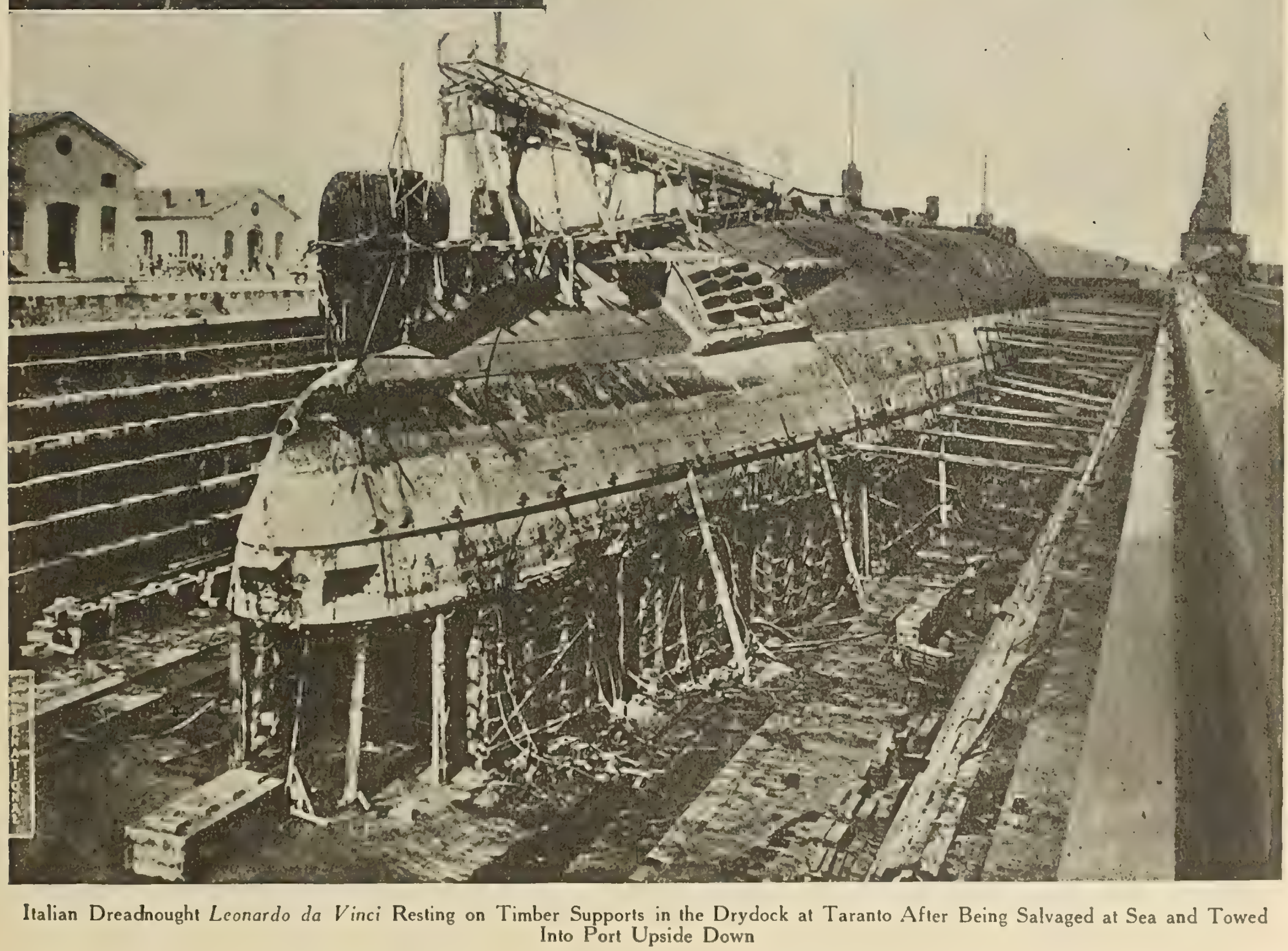
The *Leonardo da Vinci* is a battleship of 22,380 tons displacement, 575 feet 6 inches long on the waterline and 91 feet 9 inches beam, with a mean draft of 27 feet 9 inches, laid down by the Ansaldo company in 1911 and completed in 1914. Her machinery, also built by the Ansaldo company, consists of Parsons turbines of 24,000 horsepower, driving four screws, and Blechynden boilers. The vessel was designed for a speed of 22½ knots and carries an armament of thirteen 12-inch, eighteen 4.7-inch and fourteen 3-inch guns and three 18-inch torpedo tubes.

Battleship Dry Docked Upside Down

(Photographs by "International," New York)







Italian Dreadnought *Leonardo da Vinci* Resting on Timber Supports in the Drydock at Taranto After Being Salvaged at Sea and Towed Into Port Upside Down

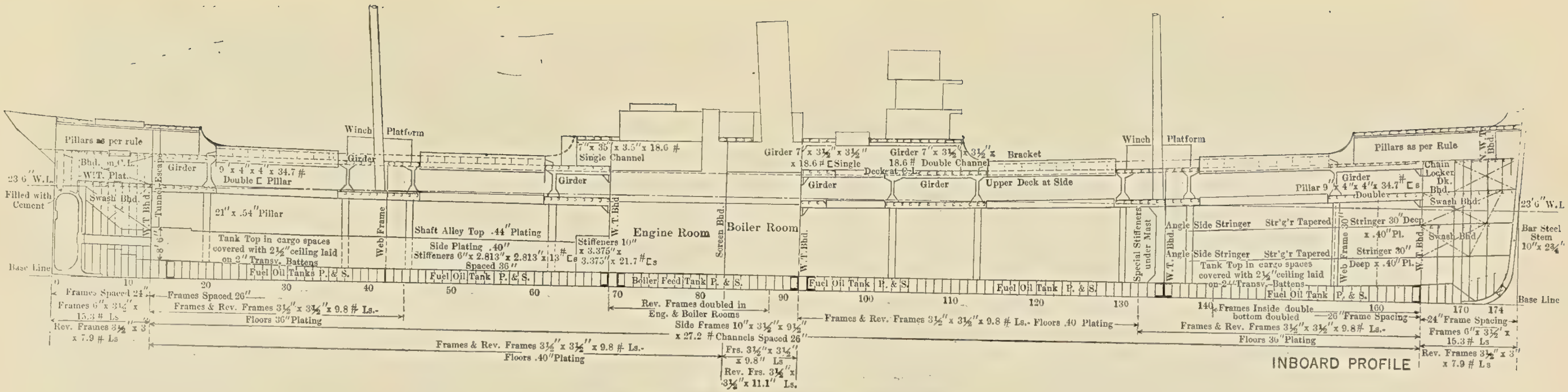


Fig. 1.—Profile of Transversely Framed Ship

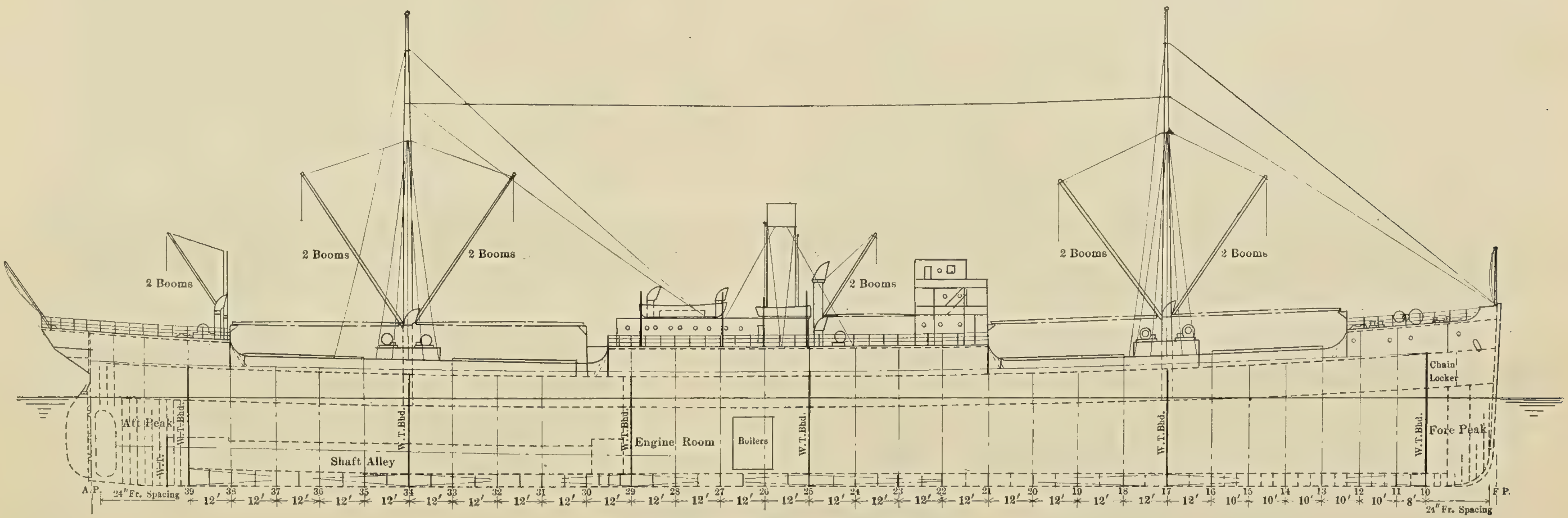


Fig. 2.—Profile of Isherwood Framed Vessel

An Analysis of the Isherwood System*

BY JOHN FLODIN, M.E.

Are the claims for the Isherwood framed ship, not only as to increased cargo capacity, but also as to strength, true? It is the first purpose of this paper to endeavor to answer these questions in the case of one specific type of vessel, the choice of which depended on the fortunate circumstance that a western shipbuilding firm, with which the author was at the time connected, changed from the transverse to the longitudinal system of construction. Other advantages claimed for the Isherwood system will also receive consideration.

THE particulars of the design under consideration are: Length between perpendiculars, 380 feet; length overall, 395 feet; length, Lloyd's, 380 feet 3 inches; breadth, molded, 53 feet; depth, molded, 29 feet 3 inches; load draft, about 23 feet 6 inches; block coefficient, .790; deadweight cargo capacity, about 7,500 tons.

The two vessels are, as shown by the profiles (Figs. 1 and 2), of the poop, long bridge and forecastle type, and both are built to the highest class of Lloyd's Register of Shipping.

In making this change in the system of construction, several minor alterations became necessary or desirable. Thus, for example, the engine and boiler casings and the deck houses were changed, the fore-peak bulkhead was moved forward, and a bulkhead was added in hold number two, at the forward end of the bridge. But, since these alterations are not chargeable to the change in the system of construction, they have either been disregarded or their effect has been equalized.

Notwithstanding the necessity to make these departures from the working drawings, this opportunity for direct comparison offers very considerable advantages. Vessels of both designs have been built and are at the present time in actual operation, so that the case cannot be regarded as a hypothetical one. We have, further, the advantage of being able to obviate reduction to standard conditions, or, in the case of steel weights, to a basis of tons of deadweight capacity per ton of steel, since the vessels are of identically the same dimensions.

In this connection attention is called to the absence of side stringers in the transversely framed vessel, this omission having been compensated for by increased stiffness of side framing and greater thickness of shell plating. Since this simplification is now quite commonly adopted, both ships may be regarded as typical of the system of construction that they represent, but it should be borne in mind that the transverse framing construction has gone through a long course of development, while the Isherwood system is relatively very young and may consequently be regarded as being in a rather rapid state of evolution.

Comparison of Weights and Capacities

Rather careful calculations of the net steel necessary to complete the two vessels show that 2,023 tons were used for the transversely framed vessel and 1,881 tons for the Isherwood ship. These figures, which are in tons of 2,240 pounds, do not include scrap; that is, deductions have been made for lightening holes, notches in the plates where continuous members pass through, etc., and no allowance has been made for rivet heads or liners. The last two items should be very nearly the same for both types of ships, so that our comparison will not suffer from the omission of them.

The saving in net steel amounts, then, to 142 tons, or slightly over 7 percent, certainly a saving well worth while, provided it is not accompanied by a reduction in strength. This, however, does not represent the increase in cargo-carrying capacity, for the reduction in weight on the basis of the completed ship, including all machinery, equipment, etc., equals only about 4.65 percent, and the increase in the deadweight carrying capacity is about 1.9 percent. To the shipowner this last figure is the only one of any great significance, for, since it may be assumed that the custom-house measurements—that is to say, the taxes levied upon the vessel—are not affected by the change in the system of construction, the increase in the deadweight capacity equals the increase in the earning capacity in all cases where the weight, rather than the volume, is the important factor, unless, of course, the cost of operating the Isherwood vessel should rise because of the need of more frequent or more costly repairs.

The increase in the earning capacity is, in fact, the principal claim for favor made by the supporters of the Isherwood system, coupled, as it is, with the claim that the grain and bale capacities are also increased. The former contention is undoubtedly true, the improvement being due partly to the fact that the saving in steel means that a smaller volume is occupied by the framing, but mainly to the greater facility with which the inner bottom ceiling may be run out horizontally to the shell plating of the Isherwood ship, instead of being run up along the faces of the margin brackets, as is commonly done in transversely framed vessels. The bale capacity (i. e., the actual, "as loaded" bale capacity, not the calculated), on the other hand, is naturally somewhat impaired because the transverses break into the cargo holds at intervals that are but rarely a multiple of any of the three dimensions of the bales. In case of ordinary bale goods this may not be a serious matter, but in case an Isherwood ship were to carry lumber it would be necessary to load "short stuff" (that is, lath, shingles, or bundled flooring or ceiling), which means a mixed cargo where a straight cargo might be more easily obtainable, not to mention the greater stevedoring charges.

In this connection attention is called to the fact that practically all oil tankers are now being built to the Isherwod system, the principal reason being that this system lends itself more readily to the peculiar bulkhead and stiffening work necessary in that type of vessel, and only secondary to the saving in steel weight. The increase in the cubic capacity has, of course, no influence on the choice of system of framing for a tanker, since the deadweight capacity, not the cubic capacity, is the significant factor.

Longitudinal Bending Strength

As a criterion of the longitudinal bending strength, we might simply find and compare the section moduli of the two vessels. The matter was, however, gone into some-

* From a paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1919.

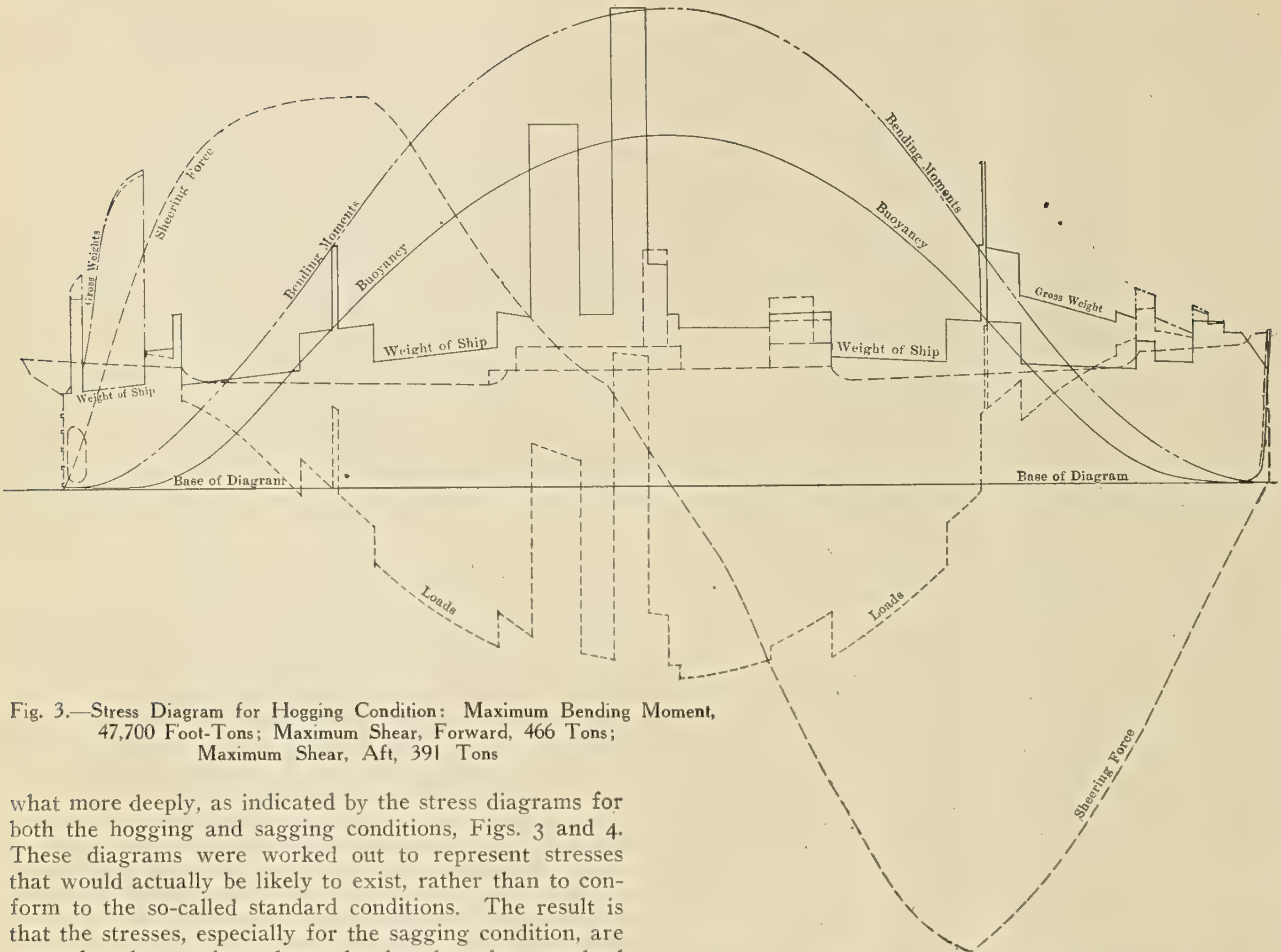


Fig. 3.—Stress Diagram for Hogging Condition: Maximum Bending Moment, 47,700 Foot-Tons; Maximum Shear, Forward, 466 Tons; Maximum Shear, Aft, 391 Tons

what more deeply, as indicated by the stress diagrams for both the hogging and sagging conditions, Figs. 3 and 4. These diagrams were worked out to represent stresses that would actually be likely to exist, rather than to conform to the so-called standard conditions. The result is that the stresses, especially for the sagging condition, are somewhat lower than those developed under standard conditions for vessels of this size, the bending moments being 41,200 foot-tons for hogging and 9,800 foot-tons for sagging.

Point of Maximum Bending Moment

It will be seen from the diagrams that the bending moment is maximum at about the middle of length for both the hogging and sagging conditions. But at this point the ship is strengthened by the long bridge, so that the point of most unfavorable combination of bending and resisting moments falls either just forward of the forward end of the bridge, or just abaft the after end of the bridge, at which points the section moduli may be taken as being equal, since the scantlings are the same at both points, only the sheer heights changing slightly. The section moduli were, in fact, calculated for the lowest point of sheer, and they may consequently be regarded as being somewhat conservative. On the other hand, in working out these section moduli an important departure from standard practice was made: the main rail and bulwark plating were included as strength members. The reason for this was that in the Isherwood ship the main rail and one of the bridge-space shell longitudinals form a practically continuous member. Since the shell longitudinal certainly is a strength member, there is good reason for including the main rail, and consequently also the bulwark plating, in the section modulus of the Isherwood ship, especially when these members are in tension. And if we decide in favor of the inclusion in the case of the Isherwood ship, the corresponding members must, of course, also be included in the section moduli of the transversely framed vessel, for the sake of retaining a fair basis of comparison.

The values of the section moduli, in inches to the third power, are:

	Hogging Condition	Sagging Condition
Transversely framed vessel......	161,900	178,100
Isherwood vessel	170,300	189,700

In each case a deduction for seven diameter rivet spacing was made from the sectional area of the tension part of the section.

By applying the flexure formula, the unit stresses, in pounds per square inch, are now found to be:

	Hogging Condition	Sagging Condition
Transversely framed vessel......	6,840	1,477
Isherwood vessel	6,500	1,392

It will be seen that the fiber stresses are, roughly, 5 percent less in the Isherwood vessel than in the transversely framed vessel.

This comparison holds good only, of course, when the vessel is in the upright position and the plane of bending is vertical, but it seems safe to conclude that an approximately similar relation of strength would be shown to exist were we to continue the analysis for various angles of inclination, and we may make the general deduction that in longitudinal bending strength an Isherwood ship is materially superior to a transversely framed vessel of the same dimensions.

Vertical Shearing Strength

A similar inference may be made for the vertical shearing strength. On the stress diagram for the hogging condition (Fig. 3) we find that the maximum vertical shearing stress is 466 tons, which is resisted by a cross-sectional area of 2,004.5 square inches for the transverse

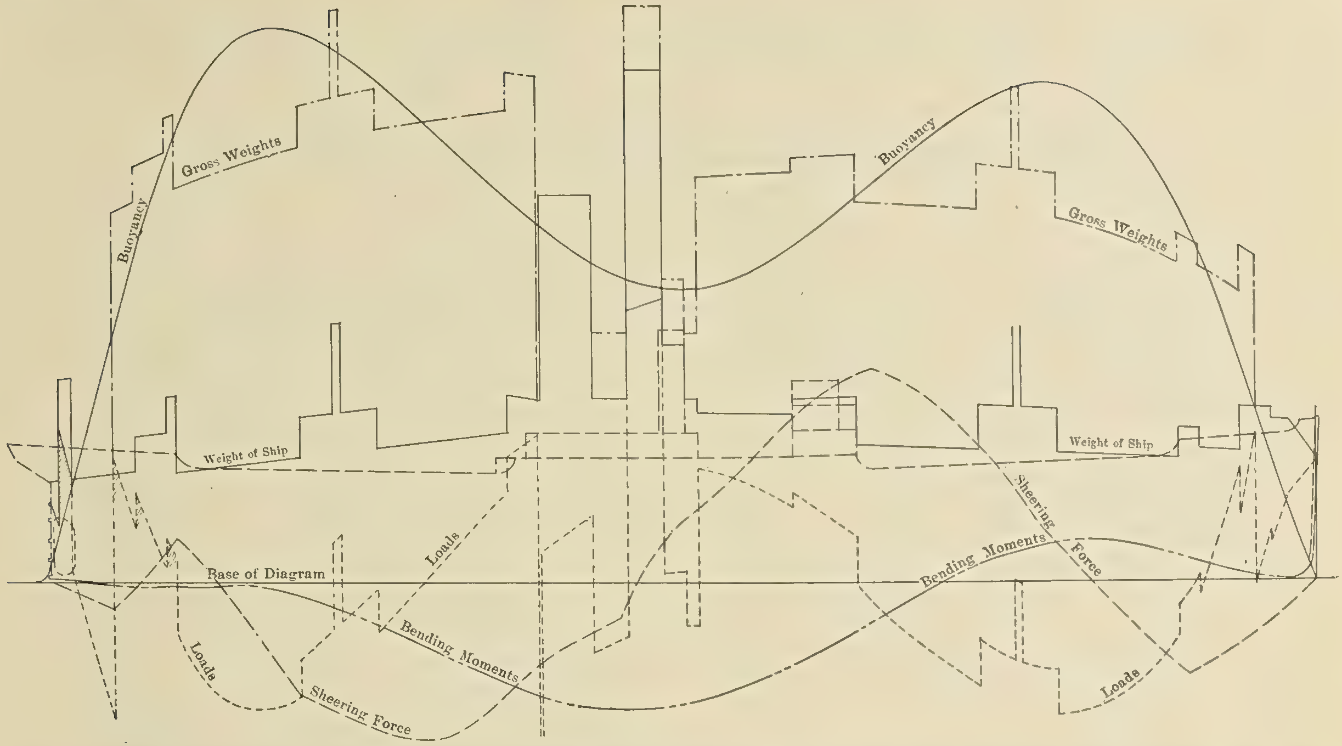


Fig. 4.—Stress Diagram for Sagging Condition: Maximum Bending Moment, 11,900 Foot-Tons; Maximum Shear, Forward, 198 Tons; Maximum Shear, Aft, 147 Tons

vessel and 2,252.7 square inches for the Isherwood vessel, giving unit shearing stresses of 520 and 468 pounds per square inch, respectively. While there is a material reduction in the unit stress in favor of the longitudinally framed vessel, this can scarcely be credited as an advantage for the Isherwood system, inasmuch as the stress values are too low for consideration.

Longitudinal Shearing Strength

Longitudinal or horizontal shear is usually found by the formula:

$$\text{Longitudinal shear} = \frac{VM_s}{tI},$$

where

V = vertical shear.

M_s = the statical moment of the section (= area $\times$ distance) between the plane at which it is desired to find the longitudinal shear and the extreme fibre, on one side of the plane of shear.

t = thickness of web at plane of shear.

I = the moment of inertia of the section.

In applying this formula to ordinary structural work, no consideration is given to transverse stiffeners or brackets, and, consequently, no careful investigation seems to have been made in this field. It is evident, however, that if the hull were to fail because of longitudinal shearing stresses, say along an edge lap in the shell at or near the neutral axis, the transverse framing would have to be sheared off along that edge lap. In the transversely framed ship we have transverse channel frames spaced 2 feet 2 inches, continuous from the bilge to the upper deck. These frames have a sectional area of 8 square inches each, but because of the elasticity of the riveting connecting the frames to the shell plating it would probably be unsafe to regard more than 50 percent of this area as effective in longitudinal shear.

At the edge lap between *H* and *J* strakes we have, then, per frame space, for one side of the ship:

	Square Inches
Gross shell plate area = 28 x .66	18.48
Less rivet holes, which for 4½ diameter spacing = 2/9 gross area	4.10
Net plate area	14.38
Effective frame area	4.00
Total area in shear	18.38

This corresponds to 8.47 square inches per foot length of ship for one side, or 16.94 square inches for both sides of the hull. The equivalent web thickness would then be 1.41 square inches.

In the Isherwood ship the case is quite different, however. We have, as before, the area of the shell plate, which amounts to 5.6 square inches per foot of ship, for one side, after deducting for the riveting. But to this area we cannot add the strength of a transverse frame. The angle connecting the transverse web frame to the shell is cut at every longitudinal, and the web plate itself is deeply notched, giving sufficient elasticity in the transverse members to make them useless in longitudinal shear. It is true that some frame rivets between the edge lap and the longitudinal would have to be sheared. If, in our case, we take the shell lap between *H* and *G* strakes as the plane of longitudinal shear, four or six rivets connecting the transverse clip to the shell between that lap and longitudinal number 16 would add to the longitudinal shearing strength. But with transverses spaced 12 feet apart, this becomes a negligible quantity and we can use the value found above, which gives an equivalent web thickness of 0.932 inch as effective in longitudinal shearing.

Using these values for *t* in the formula given above, 466 tons as the vertical or transverse shear and the proper respective values for the static moments and moments of inertia, we find that the longitudinal shear for the transverse vessel amounts to 2,570 pounds per square inch, and for the Isherwood vessel to 3,920 pounds per square inch, which shows an increase in fiber stress of over 50 percent. In either case the stress is small, however, and the reduction in strength should not be regarded as endangering the safety of the Isherwood vessel.

(*To be concluded.*)

Buoyancy and Stability of Troop Transports*

Effectiveness of Watertight Subdivisions—Loss of Stability—Ballasting—Longitudinal Bulkheads—The Case of the Empress of Ireland

BY PROFESSOR WILLIAM HOVGAARD

When a transverse bulkhead is divided into parts placed on different frames it is said to be stepped. Such a bulkhead actually consists of two or more vertical parts and one or more horizontal parts, or steps, the latter being formed by the deck or decks at which the continuity of the bulkhead is broken. Damage to the side by explosion or collision in way of a step located below the waterline is likely to open both of the adjacent compartments to the sea and thus, dependent on the length of the step, the value of the subdivision is seriously impaired. Suppose, for instance, that a bulkhead has a step 35 feet long and that the horizontal extent of the damage by an underwater explosion is likewise 35 feet; then the chance of both adjacent compartments being flooded by one explosion is practically doubled, due to the presence of the step.

Steps in bulkheads are therefore to be avoided or their lengths at least reduced to a minimum.

Recesses or horizontal steps in bulkheads are less objectionable, provided they do not extend so near to the sides of the ship as to be damaged by an underwater explosion.

Integrity of Bulkheads and Other Watertight Surfaces

Several precautions must be taken to insure the effectiveness of watertight subdivisions having for their main object to prevent the water from entering compartments other than those directly and unavoidably flooded by an accident.

In merchant vessels steps in bulkheads involve a danger in addition to that just explained, due to the fact that the frames almost invariably pass non-watertight through all decks below the bulkhead deck. When one of the compartments adjacent to a stepped bulkhead is flooded, and provided the step is situated below the waterline, water is liable to filter through the deck at the frames. The cement filling usually applied along the sides of the deck cannot be relied upon to keep tight under a considerable head of water. Thus the integrity of the stepped bulkhead is destroyed. The remedy is to fit stapling around the frame in that part of the deck which belongs to the bulkhead.

Recesses in bulkheads are not objectionable from this point of view, as they are usually watertight at the bounding decks.

The danger of fitting doors in the main transverse bulkheads of troop transports is enhanced by the difficulty of controlling the doors at all times. This may be due partly to the overcrowded condition liable to occur in troop transports, partly to the impossibility of obtaining a highly trained personnel for all such vessels under the stress of war. Great care should, therefore, be bestowed on this matter.

No doors should be allowed in main transverse bulkheads below the bulkhead deck, but this rule is not followed in passenger steamers. Doors are found partly on a low level, as between engine and boiler rooms, partly on a high level, notably on the deck just below the bulkhead deck. When such vessels are taken over for service as troop transports, all doors in transverse bulkheads on a low level in the engine and boiler rooms should be permanently closed. This, of course, will render communication and inspection more difficult, and many engineers for this reason strongly object to it. It is, however, a fact that in some of the largest American transports used during the war those doors were always closed when at sea without serious detriment to the service.

In most trans-oceanic passenger steamers the hold just forward of the boiler rooms is used as a reserve coal bunker. Often two compartments of the fore-hold are so used. Coal is drawn from the reserve bunkers through doors in the respective main bulkheads at the level of the fire room floor, and often a tunnel with a door at each end is fitted through the main transverse bunker, usually fitted in the forward end of the forward boiler room, so that coal may be drawn directly from the nearest reserve bunker. Such doors, putting two of the largest compartments in the ship in connection with each other, and being necessarily open during long periods while the ship is at sea, constitute a serious menace and should be closed under war conditions. This necessitates hoisting the coal from the reserve bunkers onto the bulkhead deck, whence it can be dumped into one of the regular bunkers, an arrangement which was adopted in several ships during the war.

The transverse main bunker bulkheads in passenger steamers are generally non-watertight with non-watertight sliding bunker doors and should be disregarded in considering the watertight subdivision; but even if such bulkheads are of watertight construction, it is best not to rely on them, since the doors will normally be open when the ship is under steam.

The following further recommendations are essentially an abstract of those given for large mail and passenger vessels under war conditions by a committee appointed by the Institution of Naval Architects in 1917 to inquire into the effects of underwater explosions on the structure of merchant ships.*

Firemen's passages should be permanently closed up and all openings from the engine rooms into shaft tunnels should be abolished, access to tunnels being provided through watertight trunks abaft the engine room bulkhead. If these recommendations are not carried out, the engine room tunnel doors should be quick-closing and capable of operation from the bulkhead deck or a deck above.

Doors fitted in main bulkheads on the 'tween deck below the bulkhead deck cannot always be dispensed with without great inconvenience to the service and without radical alterations. It is a fact, however, that such doors are very dangerous in cases where a ship takes a sudden and great list, whereby water is admitted to the 'tween decks and tends to spread forward and aft (*Empress of Ireland*). It is advisable, therefore, to close those doors, to secure them so that they cannot be opened, and to provide additional exits to the decks above where necessary.

The committee further recommended that all side scuttles situated below the first deck above the bulkhead deck be closed up and sealed. It may here be added that all side lights below the bulkhead deck should be not only closed

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1919. Concluded from the January number.

* Report of May 8, 1917. Institution Naval Architects, 1918, p. xxxvii.

but also protected by steel plates or strong watertight covers, as they are otherwise liable to be broken by the force of the underwater explosions.

Valves should be fitted on all sanitary discharges at the ship's side, such as will prevent water passing inboard through them when the vessel has a considerable trim or list.

The upper ends of ash or rubbish shoots, etc., opening on decks below the bulkhead deck should be provided with watertight covers, which should always be in place when the shoots are not in use.

Each suction pipe, where it enters the compartment from which it drains, should be provided with a screw-down, non-return or other suitable valve which can be worked from the bulkhead deck. These valves should be kept closed except when the pumps are in use.

Where ventilation trunks, etc., pass through watertight bulkheads below the bulkhead deck, valves operated from above that deck should, in all cases, be fitted at the bulkheads. No such trunks should be allowed to pierce the bulkheads at a low level.

The precautions here enumerated were carried out as far as practicable in the transports operated by the United States Navy in accordance with general orders to that effect issued by the Bureau of Construction and Repair. In the case of the *Mount Vernon* the blanking off of the side lights below the bulkhead decks proved of great value when the ship was torpedoed.

Stability

The stability of a troop transport should be such that under the above stipulated conditions of flooding there will remain a certain positive metacentric height, while the list, if any, must not be greater than that the boats can be lowered on both sides. In order to insure this result an investigation of the stability must be made. This presents no difficulty where information is at hand concerning the lines and the distribution of weights and where an inclining experiment has been made; but where such information is not available and where time is limited, approximate or crude methods must be adopted. We shall here describe the procedure followed by the Bureau of Construction and Repair during the war in such cases as occurred quite frequently when merchant vessels in an emergency were taken over by the Government and used as troop transports.

Combined Inclining and Rolling Experiment

The first point to consider was the metacentric height under various conditions of loading when the ship is intact. A fair idea of the form of the hull was obtained by lifting offsets of the bottom while the ship was in dock, or, when this could not be done, by taking internal measurements. When practicable, an inclining experiment was made and at the same time the period of roll was determined. A combined inclining and rolling experiment gives the value of the coefficient K in the formula:

$$T = \frac{KB}{\sqrt{GM}},$$

where T is the time of a single swing in seconds, B is the beam, and GM the metacentric height, both in feet.

This formula affords a ready means of estimating the metacentric height at any time, even when at sea, by simply observing the period of roll.

Table II gives the results of such experiments for a few ships.

The *America*, during the experiment, was near her light condition, although she had 4,300 tons of coal and 1,450 tons of water on board. The *Mount Vernon* was on about

Table II—Results of Combined Inclining and Rolling Experiments

Ship	Displacement at time of experiment T	G	T	K	D
	Tons	Feet	Sec.		Feet Inches
America, ex Amerika	27,500	1.4	14.0	0.220	27 6
Mount Vernon, ex Kronprinzessin Cecilie	27,250	2.5	10.2	0.223	30 9
Covington, ex Cincinnati	22,000	2.5	9.15	0.221	28 9

the same draft as she would be carrying troops across the Atlantic when on her eastbound voyage and nearing European port; she had 4,650 tons of coal and 2,570 tons of water on board. The *Covington* was fully equipped, but, like the two other ships, without troops or cargo.

Various Conditions of Loading

A careful investigation was made of the probable loading of the ships under various conditions, and the corresponding draft and trim were calculated. In particular, the following conditions were studied:

1. When a transport sails from the port of embarkation, fully equipped, with troops and cargo on board.
2. When she arrives at the port of debarkation.
3. When she sails from that port.
4. When she returns to the port of embarkation.

For each of these conditions the position of the center of gravity and the metacentric height were calculated, or, where no inclining experiment was available, the position of the center of gravity was determined by an approximate calculation.

The Period of Roll at Sea

In all cases, whether an inclining experiment was made or not, the period of roll was observed later when at sea in the various conditions of loading. As far as possible the observations were taken under circumstances when the rolling was of a fairly regular character and small or moderate in amplitude. By comparison with other ships of similar size and type, for which K was known, this coefficient was estimated for each vessel and the metacentric height calculated approximately. The following table gives the observed period of roll and the mean draft for a number of typical ships in full-load and light conditions, that is, at the beginning and end of the round trip:

Table III—Periods of Roll at Sea

Ship	After leaving U. S. Full Load D	After leaving U. S. Full Load T	Before arriving U. S. Light D	Before arriving U. S. Light T
	Feet Inches	Seconds	Feet Inches	Seconds
Leviathan, ex Vaterland	40 11	11.0	36 8	13.0
George Washington	35 0	8.0	28 5	11.0
Mount Vernon, ex Kronprinzessin Cecilie	34 6	9.0	26 0	11.0
President Lincoln	32 7	8.7	24 3	6.7
Covington, ex Cincinnati	30 9	8.1	24 6	9.9
Louisville, ex St. Louis	30 4	7.7	27 9	8.2
Aeolus, ex. Grosser Kurfurst	26 11	6.5	22 9	9.0
Pocahontas, ex Prinzessin Irene	26 9	6.0	23 3	7.5
Great Northern	26 8	7.4	21 8	7.8
Calamares	24 4	9.0	19 6	11.3
Orizaba	24 0	7.0	18 3	11.0

The Loss of Stability by Bilging and the Residual Metacentric Height

The effects of bilging on stability may be studied by calculating the change in metacentric height and the angle of heel by approximate methods. In ships subdivided on the purely transverse system it is sufficient to determine the change in metacentric height, assuming that two or

* President Lincoln, in the light condition, carried 2,400 tons of steel ballast, 2,200 tons of water and 1,700 tons of coal.

three of the largest compartments are flooded, according as the ship is required to come up to the two- or three-compartment standard respectively. In order to obtain the severest case, it may be necessary to repeat the calculation for several combinations of flooded compartments. Using the lost buoyancy method, by which the center of gravity remains fixed in position, the change in metacentric height, MM_1, is the algebraic sum of the vertical movement of the center of buoyancy, BB_1, which is always positive, and the change in metacentric radius, which is always negative and approximately equal to $\frac{si}{V}$, where i is the moment of inertia of the free surface of water in the flooded compartment, s is a factor of permeability, and V is the volume of displacement of the ship. We have, therefore, in a transversely subdivided ship

$$MM_1 = BB_1 - \frac{si}{V}.$$

When a ship is in the light condition, BB_1 is relatively small, because the water does not rise to a great height inside the ship, but $\frac{si}{V}$, which represents the effect of the free surface of water in the compartment, will have approximately its full value. The loss in metacentric height is, therefore, a maximum and, hence, the ship is in this condition most liable to take a great list. In the full-load condition, on the other hand, BB_1 is very great, while $\frac{si}{V}$ has about the same value as in the light condition, so that MM_1 is either negative and relatively small or, in some cases, even positive. Hence, after flooding, the metacentric height in the full-load condition is practically the same as when the ship is intact, and, provided there are no longitudinal bulkheads, the ship will remain upright with ample stiffness; but, as shown above, in this condition the danger of foundering by bodily sinkage or of going down by the bow or stern is at its maximum.

Calculations made for a great number of transports showed that the loss in metacentric height by flooding two of the largest compartments in two-compartment ships when in the light condition varied from 1 to 2 feet, being ordinarily about 1½ feet. In most vessels flooding of the forward boiler room, together with the adjoining forehold—generally used as a reserve bunker—gave the greatest loss in stability.

Having calculated the probable loss in metacentric height in a given ship, it remains to estimate what the residual metacentric height ought to be after bilging, whereupon the appropriate value of this element in the intact condition can be determined. Evidently the residual metacentric height must be estimated with due regard to the size of the ship and her liability to take a list.

Ships that are subdivided on the purely transverse system will remain upright so long as there is any stability left and no external forces tend to heel them over. They will be safe, therefore, with a very small metacentric height, say from ½ foot in vessels of about 500 feet in length to about 1 foot in vessels of the largest size. Assuming a loss by bilging of 1½ feet, the initial metacentric height should therefore be not less than from 2 to 2½ feet in the light condition while the ship is yet intact.

If the calculated loss is found to be greater, these figures must be correspondingly increased. This claim being satisfied in the light condition, there will generally be ample stability in the full-load condition.

Ships with longitudinal bulkheads, whether watertight or not, should have a greater residual metacentric height in damaged condition than required for ships with only transverse bulkheads. The residual metacentric height should be so calculated that under the stipulated conditions of damage the list shall not prevent the lowering of the boats on both sides of the ship, that is, the list should probably not be greater than from 5 to 10 degrees. It must be borne in mind, however, that when holes are provided in the longitudinal bulkheads, as recommended above, a rapid equalization will take place immediately after the accident and the list may be expected to decrease very fast during the first few minutes, unless other causes tending to increase it intervene. It seems reasonable, therefore, in estimating the residual metacentric height, to allow a somewhat greater angle of heel, depending on the nature of the longitudinal subdivision. Assuming a permissible initial list of from 10 to 15 degrees, it is found that the residual metacentric height should probably be not less than from 1½ feet in transports of about 500 feet in length to 2½ feet in transports of the largest size. This gives a metacentric height in the light intact condition of from 3 to 4 feet, but these figures must be regarded only as average values.

In the full-load condition the freeboard, and hence the range of stability, is a minimum; but, on the other hand, the metacentric height is likely to be greatest and does not in general suffer so much reduction by bilging. Again, if the stability is sufficient in the light condition it will generally be sufficient when the ship is fully loaded, but probably the metacentric height should not be less than from about 4½ feet in smaller transports to 5½ feet in transports of the largest size in the intact full-load condition. Here, as when in the light condition, each ship must be dealt with independently and on its own merits.

As might be expected, these requirements are not fulfilled in ordinary passenger steamers as operated under peace conditions. The *Empress of Ireland* had a metacentric height of 3½ feet when the collision occurred, at which time she was practically in the full-load condition. This was reduced to 2¾ feet* by flooding of the boiler rooms. In the troop transport of the same size the metacentric height should be about 1 foot greater. Had doors and side lights been closed on the main deck and had holes been provided in the side-bunker bulkheads, the list would soon have been reduced by equalization to less than 10 degrees, in which case the ship would probably have remained afloat and boats could have been lowered on both sides.

The *George Washington*, which has no longitudinal subdivision, satisfies practically the above requirements, having a metacentric height of 2½ feet in the light condition and 4½ feet in the full-load condition, but in the *Leviathan* these figures are 3 feet and 4 feet, and in the *Mount Vernon* 2.1 feet and 3.2 feet respectively, showing that these vessels, which have many longitudinal bulkheads, fell short of the requirements.

Ballasting

In order to secure the metacentric heights specified above, most passenger steamers used as troop transports must carry some ballast, at least when they are in the light condition. Ocean-going passenger steamers are in general designed with rather small stiffness. According to the best practice they are in the lightest condition, given almost zero stability, that is, a very small positive meta-

* According to the lost buoyancy method.

centric height, in which case they may be expected to have a metacentric height in the loaded condition sufficient for safety under peace conditions, and yet so small as to give easy movements in a seaway.* German designers of such vessels have gone further in direction of reducing the stability,† and most of the ex-German ships used as troop transports during the war have a negative metacentric height in the light condition unless they are given a considerable amount of ballast.

Ballast may be solid or liquid. Solid ballast usually consists of pig-iron, scrap-iron, cement, gravel or sand, and if permanently on board the ship is referred to as "fixed" ballast. Liquid ballast ordinarily consists of water, fresh or salt. The quantity of ballast should be determined by a careful calculation, so as to secure the desired metacentric height under various conditions of loading, but when a ship is taken over in an emergency for immediate use there is no time for elaborate calculations, and the amount of ballast required must be estimated preliminarily, based on the behavior of the ship in commercial service and on a comparison with other ships. Later, when experience has been gained at sea, the ballast may be adjusted more accurately, and here the period of roll affords a valuable guide. This procedure was followed in most of the ex-German ships used as troop transports.

On the whole, water ballast is preferable to solid ballast, since it can be more readily taken on board and again discharged when not needed, and does not in general occupy useful space in the hold. Solid ballast, therefore, should not be used except when the tanks available for water ballast are of insufficient capacity for this purpose. In many ships, however, the amount of ballast required in the light condition is much greater than it is possible or practicable to carry in the tanks, and it becomes necessary, in order to avoid shipping or unshipping of ballast on each voyage, to carry permanently a considerable weight of solid ballast, which in the full-load condition is a useless deadweight. One reason why tanks of sufficient capacity may not be available for the purpose of ballasting, even where the tank space is very large, is that when the troops are on board most of the tanks are used for fresh water, and it may not be possible at the port of debarkation to obtain fresh water in sufficient quantity or of satisfactory quality. There is then no choice but either to leave the tanks empty on the return voyage or to fill them with salt water; but the latter course is clearly objectionable, as it necessitates washing out of the tanks at the port of debarkation, for which operation there may be no time or opportunity. Hence it is often preferred to leave most of the tanks empty on the return voyage and to carry fixed ballast instead.

The need of fixed ballast would, of course, disappear if the ships were designed so as to have sufficient stiffness under all conditions, and this solution is to be preferred in vessels designed and built exclusively for troop transport, where safety under war conditions is the first consideration. In passenger steamers, designed for service in peace time, comfort is of prime importance, the stability must necessarily be small, and ballasting under certain conditions may become a necessity.

Table IV on this page gives the weight of fixed ballast carried by some of the troop transports during the war, and also the amount of water carried when the ships in the light condition were near the end of their voyage.

Longitudinal Bulkheads

Most merchant vessels are subdivided on the purely transverse system. When damaged under water they usually preserve their upright position or take a slight list, and if they founder they go down by bodily sinkage, bow or stern first. The boats can be lowered without difficulty, provided the sea is not too rough, and in well-subdivided ships ample time will be generally left for this operation (*Titanic*). At the International Conference on Safety of Life at Sea in London, 1913, "evidence was produced which made it perfectly clear that there was no known case of a vessel having been bilged in service and them capsizing. . . . ."*

Table IV—Ballasting of Troop Transports

Ship	Fixed ballast	Water, fresh and salt
	Tons	*Tons*
Leviathan	820	5020
George Washington	921	2290
President Lincoln	2400	2200
Aeolus	1300	1670
Pocahontas	1300	1370

Longitudinal watertight bunker bulkheads commenced to be introduced in merchant vessels with the *Lusitania*—primarily in order to secure coal protection against gunfire—and were subsequently fitted in certain other English liners destined to be used as auxiliary cruisers in time of war. In Germany such bulkheads were fitted in several vessels, as in the *Kronprinzessin Cecilie*, her sister-ship *Kaiser Wilhelm II* and the *Vaterland*, later used during the war as troop transports by the United States Government and re-named the *Mount Vernon, Agamemnon* and *Leviathan* respectively. In these vessels centerline bulkheads, moreover, were fitted in the engine rooms.

In other passenger steamers, as, for instance, the S. S. *Philadelphia*, used as a troop transport under the name of *Harrisburg*, side bunkers are fitted which are virtually independent of each other, since they can only equalize across the top of the boiler room on a level well above the deep-load waterline.

Side bunker bulkheads, whether watertight or not, always constitute a danger to stability in merchant vessels where adequate means of quickly correcting a list are not available. An underwater explosion on one side may cause a bunker on that side to be flooded immediately and, generally, also the adjoining boiler room. The opposite bunker will not, as a rule, be flooded so quickly, even if the bunker doors are non-watertight and open, because usually the doors are choked with coal and the water can enter but slowly. The ship, therefore, at once takes a list, and, although a gradual equalization may take place, water is likely at the same time to filter into adjacent compartments or spread over 'tween decks, so that the stability may be destroyed and the ship capsize before equalization in the bunkers can prevent it. In such a case, then, the loss of the ship is directly due, not to the longitudinal bulkhead on the damaged side, but to the intact bulkhead on the other side, and the danger is greater the more watertight that bulkhead is. In point of safety, side bunkers are useful only provided they are narrow, well subdivided and watertight, and then only in cases of minor damage, where the side bulkhead remains intact. It is best, therefore, to avoid all such bulkheads in merchant vessels.

The danger of side bunkers in passenger vessels became evident by the loss of the *Lusitania* on May 7, 1915. The *Lusitania* was going at about 18 knots speed when she was hit almost simultaneously by two torpedoes on the starboard side abreast of the boiler rooms. One of the torpedoes hit near the bulkhead separating boiler rooms 1 and 2. Lifeboat No. 5, which is about 160 feet aft of that

* L. Peskitt, Institution of Naval Architects, 1914, p. 191.
† P. Driessen, *Schiffbau*, 1909, p. 269.

* Sir A. Denny, Institution of Naval Architects, 1914, p. 204.

bulkhead, was destroyed by the blast of an explosion, but whether from the same or the other torpedo is unknown. The ship at once took a list of about 15 degrees, undoubtedly due to the presence of the side bunkers, and this list gradually and rapidly increased, due to infiltration of the water, especially through open sidelights. At the same time the bow was sinking deeper into the water than the stern. In less than twenty minutes after the explosion the ship capsized and sank. The initial list was so great that it was practically impossible to lower the boats on the port side, although the sea was calm. Due to this fact and the short time available before the ship went down, about 1,200 lives were lost out of a total of about 1,950 persons on board the ship.

Centerline bulkheads are no less objectionable and dangerous in merchant vessels than in warships. A calculation shows that in the *Leviathan* flooding of the two engine rooms on one side will produce a list of 19 degrees, and in the *Mount Vernon* of 21 degrees, while in the *George Washington*, where there is no centerline bulkhead, flooding of the main engine room will leave the ship upright, the sole effect being a sinkage of about 2½ feet, with a total change of trim by the stern of about 5 feet.

A more insidious source of danger is found in many merchant steamers—even such as are ostensibly subdivided on the transverse system—due to the existence of "shifting bulkheads" fitted longitudinally inside transverse bunkers, usually at or near the centerline and often on top of a tunnel. These bulkheads, which are fitted for the purpose of preventing the coal from shifting, are non-watertight and are in some ships provided with holes, which in case of bilging permit an equalization of the water from one side to the other. Ordinarily, however, the water must rise to a considerable height on one side before it begins to equalize, especially where the bulkhead is fitted over a tunnel and the holes are at a high level. Often the flow is very sluggish, because the openings are choked by coal. Thus, shifting bulkheads temporarily, at least, have the same effect as watertight longitudinal bulkheads.

A striking proof of the dangers of such quasi-longitudinal subdivision is furnished by the loss of S. S. *Empress of Ireland* in May, 1914, as the result of a collision with the S. S. *Storstad*. The *Empress of Ireland* had two large boiler rooms, each with a cross bunker at either end connected by side bunkers. All the bunker bulkheads were non-watertight. Water could flow freely from the side bunkers into the adjacent cross bunkers, but at the centerline in these latter were longitudinal passages and shifting bulkheads, which, although provided with holes, greatly retarded the equalization of water from one side to the other inside the bunkers (see Fig. 2). The ship was otherwise subdivided on the transverse system. At the time of the collision the bunkers were practically full of coal.

The *Storstad* struck the *Empress of Ireland* almost at right angles on the starboard side in way of bulkhead No. 5, which separates the two boiler rooms from each other. A breach was produced in the side of the *Empress of Ireland* of an area below the waterline, estimated to be not less than 350 square feet—about the same size of hole as would be produced by the explosion of a torpedo. The immediate effect of the damage was that the watertightness of bulkhead No. 5 was destroyed and that both boiler rooms were put in communication with the sea. Flooding of these compartments involved a mean sinkage of practically 9 feet, which took the main deck 4 feet below the water at the centerline amidships. At the same time the ship took a heavy list.

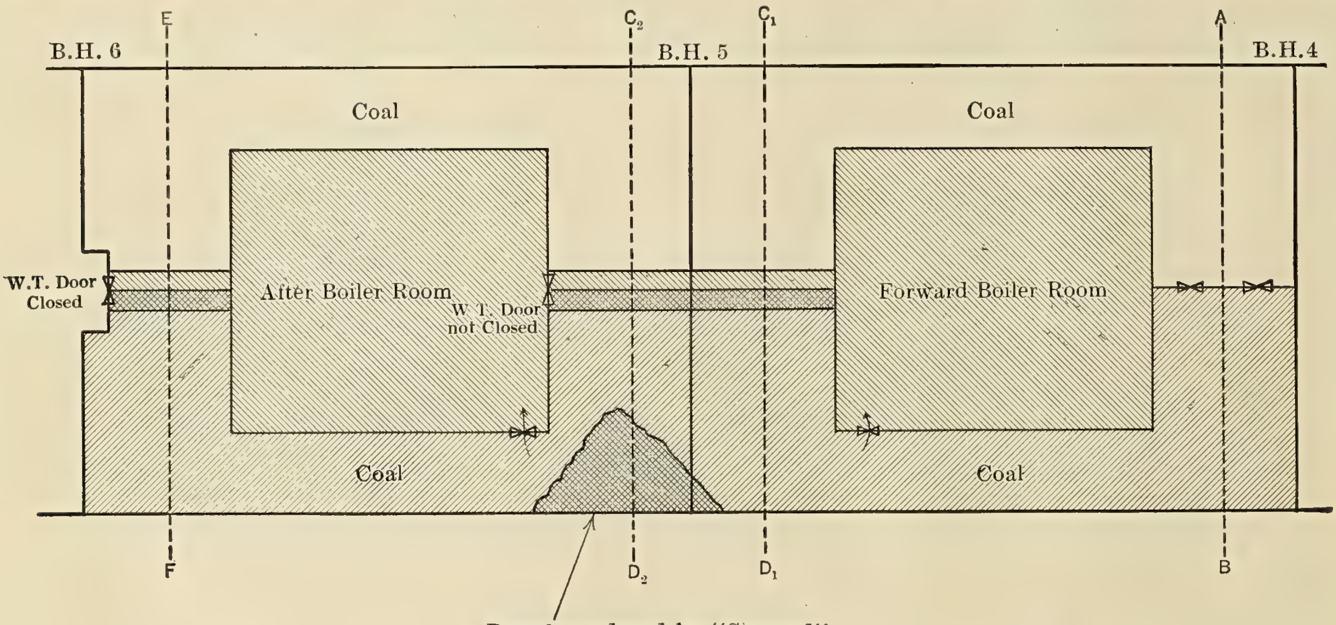
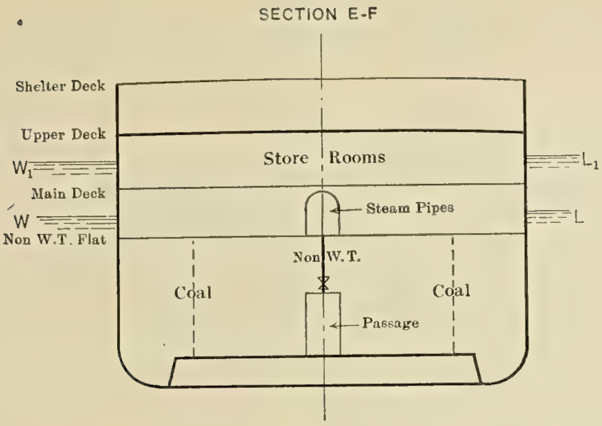
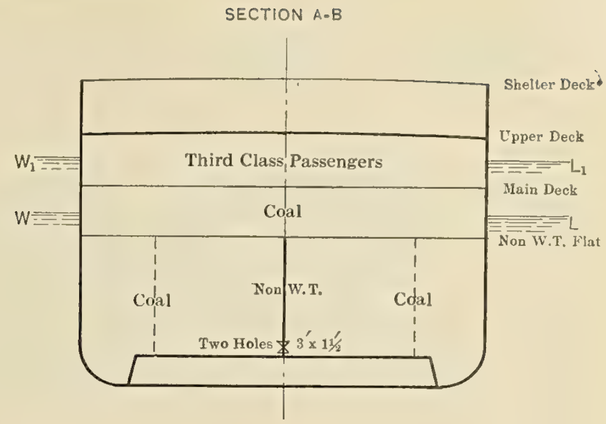


Fig. 2.—*Empress of Ireland;* Plan of Boiler Rooms

Quoting from the Parliamentary Report, p. 17: "There is no evidence that the *Storstad* destroyed any portion of the bunker bulkheads, so that very shortly after the impact a large quantity of water must have entered the bunkers on the starboard side for the whole length of the boiler rooms, which water was able to escape only through bunker doors in the boiler rooms and relatively slowly also across the middle-line partitions in coal bunkers to the port side of the vessel. Under these circumstances the ship would at once commence to list to starboard * * * making reasonable approximations, an inclination of some 15 to 20 degrees appears probable. * * * From such a list the vessel might have recovered as the water got to the port side, if all port holes and all watertight doors in bulkheads bounding the boiler compartments up to the upper deck had been closed, but with doors and side lights open





to the extent known to have obtained after the collision, water was free to enter other compartments, and the final capsizing and foundering became inevitable."

It is clear from this that it was owing to the presence of side bunkers and shifting bulkheads that the ship at once listed to such an angle that it was impossible to lower the boats on the port side and that equalization in the bunkers was delayed. Open side lights and bulkhead doors between the main and upper decks allowed the water to enter and spread forward and aft on the starboard side of the main deck, and before equalization could become effective the stability was wholly destroyed. About fifteen minutes after the collision the ship capsized and foundered with a loss of more than a thousand lives. This disaster happened in a perfectly calm sea and in a ship which was generally considered well designed and safe.

Longitudinal shifting bulkheads are fitted also in the cargo holds of all merchant vessels which carry cargoes that are liable to shift, but are in such case ordinarily provided with large door openings at the foot, and under the cargo hatches portable wooden partitions take their place, allowing a fairly free equalization of the water in case of bilging.

The obvious remedy against the ill effects of longitudinal subdivision is in all cases the same—to destroy the integrity of the longitudinal bulkheads by cutting permanent openings of ample size in them at the lowest possible level. In centerline bulkheads in engine rooms it will generally be sufficient to remove existing doors or to secure the doors in the open position, so that they shall never be closed while the ship is at sea. If, however, the doors are of small area or placed at a high level, permanent openings should be cut at the foot of the bulkheads. Prof. C. Pagel, Director of the Germanischer Lloyd Classification Society, in 1916,* speaking of the danger of centerline bulkheads, made the following statement: "Hence, for those of our (the German) passenger steamers that are provided with a centerline bulkhead in the engine room, it is prescribed that in such a bulkhead great doors shall be fitted, which must be open during the voyage, so that, in case of bilging, water can flow to the endangered side and thus a great list be avoided." In the shifting bulkheads of transverse bunkers, similar holes should be cut of sufficient size to allow for the obstruction to the flow of the water caused by the coal. Where tunnels extend to a great height above the floor of the bunkers and are surmounted by shifting bulkheads, holes cannot be cut at a low level, and it may here be necessary to fit equalizing pipes or ducts under the tunnels. In side bunker bulkheads holes of ample size should likewise be cut, and, in order to prevent the coal from running out,

* Jahrb. Schiffb. Ges., 1916, p. 142.

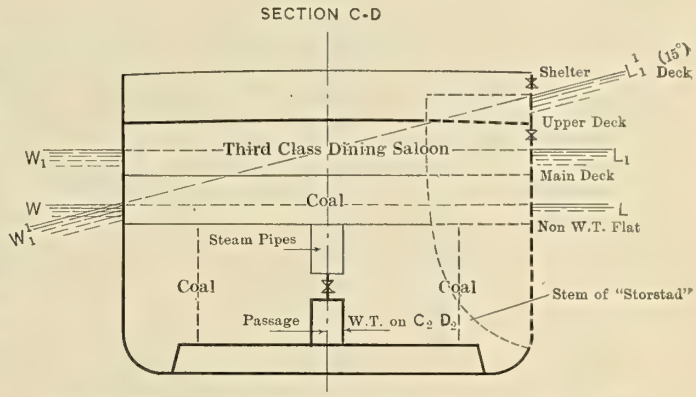


Fig. 3.—*Empress of Ireland;* Sections Through Boiler Rooms

they should be provided with grating or wire mesh. The precautions here described serving to annul or reduce the heeling effect of longitudinal subdivision were taken by the Bureau of Construction and Repair as needed in all the troop transports under the control of the United States Navy during the war.

Lloyd's Shipbuilding Returns

The returns compiled by Lloyd's Register of Shipping, which only take into account vessels of 100 tons and upwards, the construction of which has actually commenced, show that there were 757 merchant vessels of 2,994,249 gross tons under construction in the United Kingdom at the close of the quarter ended December 31, 1919. Of these vessels, 616 of 2,395,412 tons are under the inspection of the surveyors of Lloyd's Register with a view of classification by that society.

As compared with last year, when only 1,979,952 gross tons of merchant shipping were under construction in the United Kingdom, the present figures show an advance of over a million tons in the twelve months. The leading district in the United Kingdom is the Clyde, where 155 vessels of 683,940 gross tons are under construction, but the district which has shown the greatest increase for the last quarter is the Tyne, where 114 vessels aggregating 593,189 gross tons are under construction, an increase for the quarter of 10.5 percent.

Outside of the United Kingdom the volume of merchant shipping under construction amounts to 4,867,114 gross tons, of which the United States is building 2,966,515, or less than the total now under construction in the United Kingdom. France shows an increase of 42,000 tons and Holland 40,000 tons. The figures for the whole world are 7,861,363 gross tons, about 60 percent of this being built under the supervision of Lloyd's surveyors with a view to classification by that society.

Superheated Steam and Operating Costs

BY H. B. OATLEY*

The fact that marine engineers abroad have come to the use of superheated steam is evidenced by the many ships contracted for and laid down since the armistice in which superheat has been specified. Further evidence is shown in the reports of new construction made public in the technical press. The rapid strides being made in England and on the Continent will be better appreciated by referring to the table published in connection with this article, which, while incomplete, is impressive. It should serve to focus the attention of American shipowners and shipbuilders more than ever before upon the necessity of putting American ships on an equal basis with foreign tonnage, so far as the economies in fuel obtainable through these means is concerned.

THE thought now being given by engineers in this country to the use of superheated steam is not only timely, but it is a compelling necessity, now that we are embarked upon a merchant marine programme that involves the factor of competition. A still more encouraging sign is the action of some of the progressive shipbuilders in this country who are now laying down vessels for their own account or for American owners. Having realized the limitations of vessels constructed during the war, they have decided to eliminate unfavorable equipment and employ those which will contribute towards a reduction in operating expenses. This idea was expressed by an official of one of the leading shipyards in the United States when he wrote:

"The vessels are to be constructed for our own account, and it is our desire that in every respect the power plant shall be the best which can be produced."

TABLE I

	No. of Ships	Type of Ship	Type of Engines	Horsepower (Each)	Degree Superheat
For British or British Colonial Ownership	3	Tankers	Triple	2500	200
	3	(*)	Gear Turb.	1500	150
	1	Cargo	" "	3000	100
	2	"	Triple	2500	200
	2	"	Gear Turb.	5000	200
	2	"	Triple	2600	200
	3	Pass. & Cargo	Gear Turb.	13500	200
	4	" "		1400	200
	3		Gear. Turb.	3500	200
	2	Pass. & Cargo		4500	120
	2	" "		4500	200
	1	" "	Gear Turb.	6000	150
	10	Passenger	" "	13500	200
	12	Tankers	" "	1500	200
	2	Pass. & Cargo	" "	3000	150
	2	" "	" "	3500	150
	2	" "	" "	4500	150
	1	" "	" "	6500	150
	1	" "	" "	5000	150
	1	Cargo	" "	5000	150
	5	Refrigerator	" "	4250	150
	3	Cargo	" "	3000	200
	3		" "	3500	200
	3		" "	5000	200
	2		" "	6000	200
	1	Pass. & Cargo	" "	5000	200
	1	" "	" "	8000	200
	2	" "	Quadruple	4000	200
	1			2500	100
	1	Pass. & Cargo	Gear Turb.	14000	150
	1	" "	" "	5000	200
	1	" "	" "	4500	200
	1	Cargo	" "	3000	150
	4	"	" "	2000	120
	4	Pass. & Cargo	Gear Turb.	5000	200
For French Ownership	3	Pass. & Cargo		4000	275
	2	Cargo	Gear Turb.	2500	280
	2	"	" "	5000	200
For Danish Ownership	12	Cargo	Recip.	750	200
For Holland Ownership	12	Pass. & Cargo	Gear Turb.	3500	150
	1	" "	Triple	4500	200
	1		Gear Turb.	3500	200
For Norwegian Ownership	2	Cargo	Triple	3500	200
For Italian Ownership	1	Passenger	Gear Turb.	20000	200
For Swedish Ownership	2	Cargo	Triple	3000	200
	130			572050	

* Converted sailing ships.

It is a problem which needs the prompt and energetic action of our shipbuilders, and if such action is taken we may confidently expect that American shipyards will step into the first rank in building ships for most effective operation. The use of superheated steam will become better and more favorably known in the United States and Canada as this interest takes form in an investigation of these foreign ships which are successfully making use of it at the present time.

That superheated steam is receiving more consideration than formerly will be evidenced by Rear Admiral C. W. Dyson's paper in the August *Journal of the American Society of Naval Engineers*. He says: "The advantages derived is of such great amount as to be worthy of the most serious consideration." Table II (above the dotted line) is arranged from the data given in his paper; below the dotted line the figures are taken from the curves showing water per shaft horsepower (see Fig. 1 in his paper).

TABLE II

Percent Engine Power	Degree of Superheat	Steam Saving	Saving Per Degree
		Percent	Percent
30	41	6.7	0.163
50	46.3	7.0	0.151
100	58.6	8.0	0.136
....	......	......	......
110	60.5	8.98	0.146
120	62.0	9.43	0.153
130	63.3	11.00	0.176
140	64.0	11.55 (Est.)	0.181 (Est.)

The figures for rates above 100 percent are to be noted particularly, as a reading of the paper might lead to the conclusion that there was a steady decrease in the saving per degree of superheat. At the higher rates of engine power the *saving per degree increases,* although the degree of superheat is not increased to a marked extent. The increased saving at the higher rates of power, which is characteristic in superheated steam operation, is one of the excellent reasons why highly superheated steam is in such common use in the merchant marines the world over and explains its rapid increase in popularity evidenced by more than 2,000 vessels in operation or building.

In Fig. 1 there is reproduced curves *A* and *B* from Admiral Dyson's paper, and also curves from two locomotives tested under complete and accurate conditions. It will be of interest to note the characteristics of both sets of curves. It will also be interesting to note the remarkably low steam rates obtained by using high degrees of superheat and to see how closely they approach good marine practice. This feature is remarkable when consideration is given to the fact that a simple non-condensing engine is being compared with a triple-expansion condensing plant.

* Chief engineer, Locomotive Superheater Company, New York.

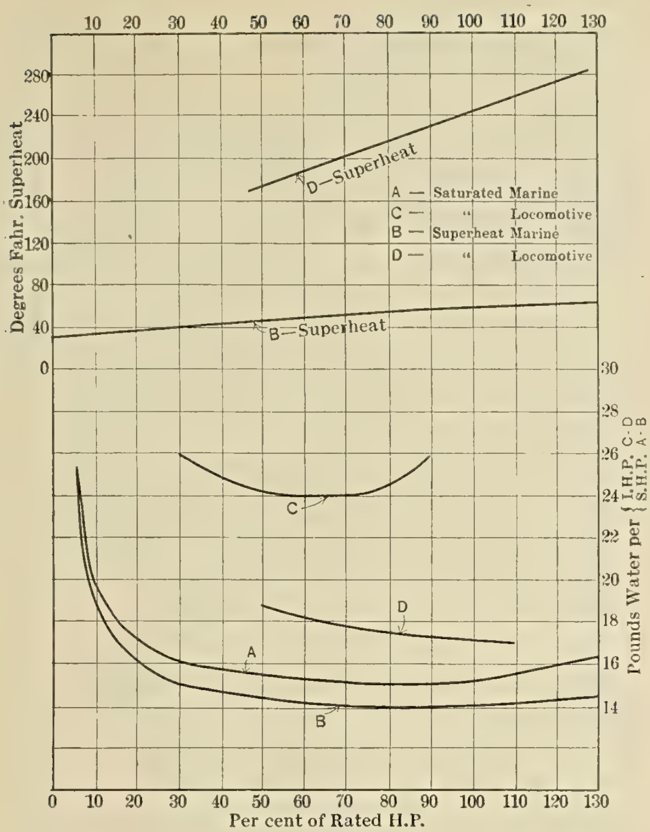


Fig. 1

It is self-evident that a higher degree of superheat in marine practice would produce economies in both steam and fuel. It is reported that the Navy Department is planning to use higher degrees of superheat on new construction, and in this respect is adopting the practice being followed in other navies.

The paper by Admiral Dyson also states that the "average rough figure for the gain due to superheating may be taken as one percent gain for every ten degrees of superheat." The inference is that this has reference to the fuel economy and not to the steam economy. At any event, every 10 degrees of superheat may, with triple-expansion engines, be safely counted upon to produce one percent saving in fuel, providing that the superheater is correctly designed, installed and operated.

In Admiral Dyson's paper stress is laid on the steam saving, and little is said relative to the fuel economies obtained on the naval vessels which he has analyzed. While fuel economy in naval practice is of great importance, it figures less from a financial standpoint than in merchant service.

The fuel economy on merchant ships resulting from superheated steam operation is generally acknowledged, but its importance will justify repetition. In Table III is given the fuel used per hundred deadweight ton miles for a number of ships, the logs of which are available and should be food for thought by shipowners. These data have been collected from ships of varying sizes, having several different methods of propulsion and using saturated steam as well as different degrees of superheat.

While different forms of hull, and class of vessel, will

TABLE III

NAME OF VESSEL	Deadweight Tonnage	Type of Engines	Superheat in Degrees F.	Coal (in pounds) per 100 Deadweight Ton-miles.			Horsepower, Shaft or Indicated
				Saturated Steam	Up to 150 degrees Superheat	Over 150 degrees	
Tellus	2600	Tr. Ex.	200			3.26	650
Adonis	2840	" "	175			4.25	700
Manta	3470	" "	None	5.15			
Kaskaskia	3900	" "	"	5.79			
Arcturus	4600	Elec.	200			2.46	
Elinor	4600	Turb.	50		6.76		
Griqua	5700	Tr. Ex.	200			3.56	1500
Canadian Voyageur	6000	" "	None	4.10			
Moreni	6750	" "	200			2.80	
Port Phillip	6780	" "	None	4.92			
Port Augusta	6800	" "	200			3.67	2150
Shimosa	7000	" "	None	5.25			
Dennis	7200	" "	"	4.32			
Stephen	7400	" "	200			3.15	2000
Bear	7500	" "	None	5.72			
El Rio	7500	" "	"	4.38			
Ferrona	7650	" "	200			2.96	1925
Malden	8550	" "	None	4.90			
Harben Maru	8600	" "	200			3.14	
Alban	8700	" "	200			3.36	2500
Eastern Sun	8800	" "	150		3.80		
West Cape	8800	" "	None	6.24			3000
Phidias	9400	" "	200			3.10	3000
Oswald	9500	" "	200			2.97	2500
U. S. S. Thomas	9650	" "	None	5.85			
Melania	9720	" "	200			2.80	2400
Pearl Shell	9750	" "	200			2.88	2400
City of Corinth	9800	" "	200			3.13	2585
Oswego	9800	" "	200			3.17	
Nias	9870	" "	200			3.22	2300
Bolton Castle	10000	" "	200			3.07	2700
Batjan	10400	" "	200			3.37	3000
Kathlamba	10500	" "	200			3.03	2900
City of Canton	10600	Turb.	150		3.94		
Lepanto	10600	Tr. Ex.	200			3.03	2500
Saratoga	10600	" "	None	6.35			
Eastern Light	10700	" "	"	4.87			
Kandahar	10800	" "	200			2.99	3150
Appeles	11000	" "	200			3.02	4000
City of Newcastle	11000	" "	50		4.20		
Ohioan	11000	Quad.	None	4.42			
Tsuyama Maru	11000	Tr. Ex.	200			2.88	
Madioen	11300	" "	200			3.78	3500
Keelung	11200	" "	200			2.98	3350
Leitrim	11700	2-Turb.	125		3.72		5000
Tokuyama Maru	11700	2 Tr. Ex.	200			2.50	3500
Toyohashi Maru	11700	2 " "	200			2.75	3500
Defiance	11800	Turb.	20		4.37		3000
Finland	11925	Tr. Ex.	None	6.95			
Tobe Maru	12000	2-Tr. Ex.	200			2.81	3000
Radja	12500	Tr. Ex.	200			3.19	
Armagh	15000	2-Turb.	125		3.71		10000
Hawaii Maru	15800	2-Tr. Ex.	175			2.64	
			Average	5.28	4.36	3.10	

cause a variation in the fuel consumption, it will, nevertheless, be of interest to compare the figures of superheated steam operation with similar ships using saturated steam.

In considering the use of superheated steam, the first question is that of the degree of superheat to be delivered at the engine. The best practice at the present time is for 200 degrees of superheat with reciprocating engines, 100 degrees to 150 degrees with geared turbines, and 250 degrees in turbo-electric-driven ships. There must also be assurance that the specified amount of superheat will be delivered under the varying operating conditions. One of the early difficulties encountered was to prevent the superheat disappearing under abnormal conditions, which, when it happened, permitted water to pass through the superheater and reach the engines. The designs which were faulty in this particular have long since been abandoned in the countries which lead in the use of superheated steam in marine practice.

The selection of proper materials for such details as come in contact with superheated steam is another important question. Steam pipes are best made of steel. Their flanges and fittings may be of semi-steel or cast steel. Valves should have bodies of cast steel or high-grade bronze of suitable composition. Valve springs and seats should be of alloy steel, or its equivalent. In turbines the blades and nozzles are commonly of alloy steel or special material determined by the turbine manufacturers and known by them to be suitable for operating conditions. Turbine casings are satisfactory when made of cast iron or cast steel, as determined by the manufacturer.

In reciprocating engines the cylinders and valve casings are satisfactory when made of a good grade of cast iron, but material which is not satisfactory with saturated steam will not be advisable with superheated steam. Piston valve rings and piston rings do not need to be different in material from what has been used, but in construction may require improvement, particularly if the design in question has been unsatisfactory with saturated steam. Rod packings must be metallic.

With reciprocating engines internal lubrication of the high-pressure valve and cylinder must be provided. Oil suitable for the conditions must be used. It is sometimes claimed that no lubrication is necessary with superheated steam, but experience on hundreds of ships has proven the fallacy of this contention. It may safely be said that, if a reciprocating engine can be satisfactorily operated without lubrication in the valve and cylinders, saturated steam is being used and that the water it contains provides lubrication. It is the absence of this which renders oil lubrication necessary when superheated steam is being delivered to the cylinders.

If steam, either moderately or highly superheated, is used, it is essential that means for determining its temperature be provided. Pyrometers or thermometers should be installed. Pyrometers should have the indicator located on the gage board in the engine room, thus permitting the temperature of the steam from each boiler being read at a glance. There is no better way of determining the firing conditions than by a pyrometer. It makes possible the correction of poor firing conditions in time to forestall a drop in boiler pressure.

Oil filters, of either the pressure or gravity types, as fitted in practically all recently built vessels, are suitable for removing oil and grease from boiler feed water. In superheated steam installations the added quantity of oil required is not sufficient to require increase in the size or number of oil separators. The cleaning of filters and oil separators must not be neglected.

The development of satisfactory superheating equipment has been a long and difficult problem. The rapid increase in the past five or six years in the number of vessels fitted with superheaters is an unmistakable answer as to whether success has been attained, both in respect to the design of the equipment and to the overcoming of operating difficulties. It is believed that a great deal of the reluctance to adopt superheated steam is due to the failures experienced during the days of development and to the fact that many of the marine engineers in this country have had in the past, and in other countries, experience with types of superheater which did not give good service and were abandoned. Modern designs of superheaters in general use are built with these early difficulties as a warning. The materials of construction now available have ensured durability and long life; selection of proper location for superheaters has ensured continuous delivery to the degree of superheat desired; study of details has ensured accessibility and ease in making repairs. In general, it is believed that the present designs of superheater should overcome all but the deepest-seated prejudice against the use of superheated steam.

A Balsa Ice Chest for Deck Installation

EARLY last summer a Swedish steamship company, the Grangesborg Oxelosund, requested the American Balsa Company, Inc., New York, to construct an ice chest for the storing of perishable food products on its ore steamer *Narvik*. Previous to the building of the ice chest the steamer had not been fitted with any arrangement for refrigeration; and as all the space was being otherwise utilized, the bridge deck was decided on as the only possible location. The ice chest, therefore, had to be constructed as a complete unit and swung aboard the ship upon its arrival. Time was an important factor and quick action was necessary.

Fig. 2 shows the details of the ice chest as actually built. A framework was constructed of yellow pine sills

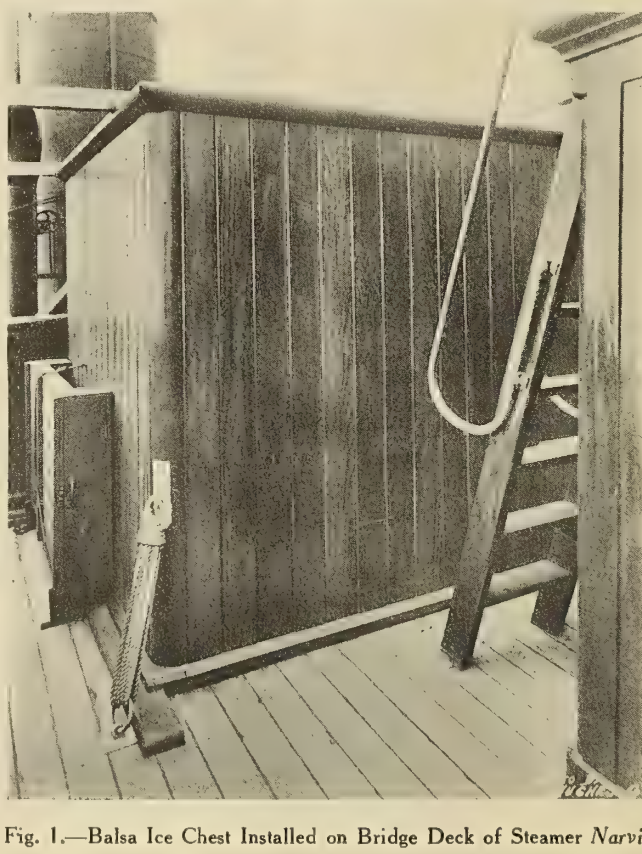


Fig. 1.—Balsa Ice Chest Installed on Bridge Deck of Steamer *Narvik*

and corner posts, tied together with 1½-inch by 3-inch yellow pine studs, toe-nailed to the sills. Balsa insulation was then put into place and after covering the inside and the outside surfaces with a layer of paper the outside of the ice chest was finished with a layer of 1⅛-inch tongued and grooved yellow pine sheathing. The inside of the chest was similarly lined with a layer of ⅞-inch spruce.

The insulation itself was applied in two layers, the outer of these being three inches thick and placed between the framing and studs. The inside layer was made one inch thick and was installed as a continuous and unbroken lining. It will be observed that by this method of construction the sills, corner posts and studs were completely insulated at all points with Balsa.

An ice bunker was built into one end of the chest, consisting of a grating of 2-inch by 3-inch oak strips placed across the chest on two stringers 16 inches above the flooring. Oak battens 1½ by 1½ inches separated the ice from the side walls of the chest. The ice compartment was divided from the remainder of the chest by a solid 1¼-inch removable oak partition with openings at top and bottom to permit free circulation of air. The entire floor was covered with galvanized iron, over which was laid a grating of spruce, made up in sections to permit of their being easily taken up.

The storage of food products was provided for by a row of shelves arranged along the side of the ice chest and two rows of meat hooks attached to the ceiling. A single door at the end of the chest gave access to the interior. A lashing ring was attached to each of the four corners of the complete chest for securing the latter in place on the ship.

This ice chest was completed in a little more than three days and was ready for swinging on the ship when the latter arrived in New York. After loading the box with ice and provisions a careful record was kept of its performance during the first trip on the steamer to Gothenburg, Sweden. The test was very severe, especially as it took place during one of the hottest periods of the summer. On June 20, about 3,000 pounds of ice, which had been delivered to the pier, were loaded into the ice chest. After the steamer arrived in Gothenburg not all of this ice had melted and the test was accordingly continued until July 14, while the ship was lying in the harbor.

In accordance with the report of the officers on board, about 110 pounds of ice were left on July 14, this being a week after the ship had arrived at Gothenburg, and twenty-five days after the ice had been put into the chest. Neither the ice chest nor the food had been precooled. The door of the ice chest had been opened about three times a day, and on July 14 "the food was in perfect condition exactly as when delivered in New York." The outside temperature during this part of the year varied from 75 degrees to 85 degrees F. in the shade. The ice chest, being located on the bridge deck of the ship, was without any protection and was subjected to the direct rays of the sun and the full force of the elements. The actual temperatures recorded were as follows:

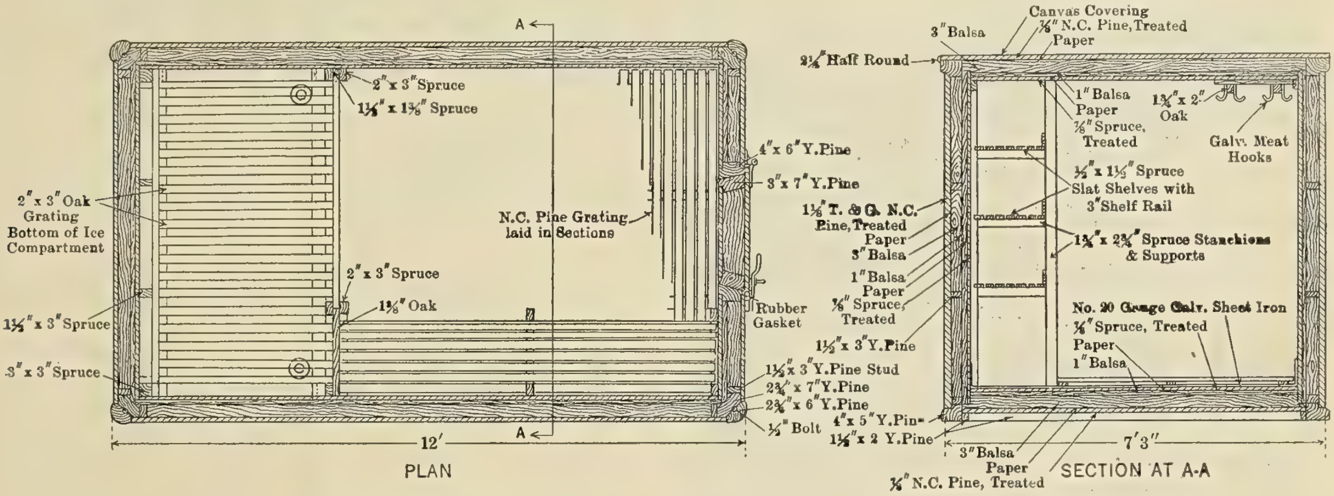


Fig. 2.—Plan and Section of Ice Chest, Showing Details of Construction

	Morning		Evening	
	Degrees F.	Degrees C.	Degrees F.	Degrees C.
June 20......			59.	15
" 21......	42.8	6	42.8	6
" 22......	42.8	6	42.8	6
" 23......	39.2	4	41.	5
" 24......	39.2	4	41.	5
" 25......	41.	5	42.8	6
" 26......	42.8	6	42.8	6
" 27......	42.8	6	42.8	6
" 28......	41.9	5½	42.8	6
" 29......	41.	5	42.8	6
" 30......	41.	5	41.	5
July 1......	40.1	4½	41.	5
" 2......	39.2	4	41.	5
" 3......	39.2	4	41.	5
" 4......	39.2	4	41.	5
" 5......	39.2	4	41.	5
" 6......	41.	5	41.	5
" 7......	41.	5	41.	5

The Balsa with which the ice chest was insulated is the product of a very fast-growing tree, native of Central America. In its natural condition Balsa is subject to rapid decay. It is accordingly "encysted" or treated against rotting by a process owned and perfected by the American Balsa Company, Inc., during which process the Balsa is completely penetrated and the individual cell walls coated with a preservative material. This treatment, however, does not fill the cell walls and the Balsa emerges from the process with a weight of only eight or nine pounds per cubic foot, which is considerably lighter than any other insulator.

After treatment this material is manufactured into large sections up to 36 inches in width and 8 to 10 feet long, corresponding approximately to the distance from floor to ceiling. The individual units of these sections are joined together by special machinery. The result is that such a completed section is to all practical purposes the equivalent of one solid piece, as the joints are both air-tight and mechanically as strong as the material itself.

The edges of these sections are provided with tongues and grooves. The completed sections are covered with a waterproof coating over which a layer of waterproof paper is applied. When assembling the chest, all that was necessary was to slip these completed sections into place and apply the spruce and pine sheathing, resulting in not only a great saving of time and labor, but producing a well-made and efficiently insulated ice chest.

On the basis of numerous tests conducted by various recognized authorities, Balsa ranks, it is claimed, among the most efficient heat insulators known. It is, however,

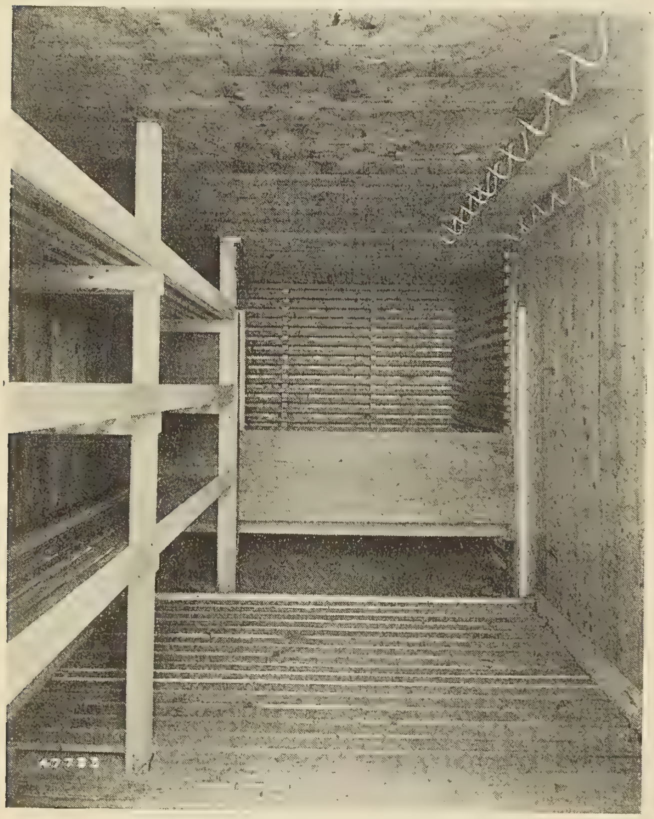


Fig. 3.—Interior of Balsa Ice Chest

the only insulator which has structural strength. In spite of its light weight, its strength per unit of weight is greater than that of spruce. It is, therefore, not only self-sustaining, but can frequently be used to carry some of the stresses of the structure itself. Furthermore, it is not liable to deterioration by shaking down, opening up of joints, etc., and in its waterproof condition will remain indefinitely without absorbing any moisture. In fact, this moisture resistance is so perfect that Balsa is now used in large quantities for the manufacture of fishermen's net floats, life rafts, surf boards and similar buoyancy products which are required to remain in the water continuously throughout a considerable period of their life.

The performance on the steamer *Narvik* was considered so gratifying that the additional steamers of this same company have been equipped with similar installations which have served in an equally satisfactory manner.

Everybody has struck days when everything seems to go wrong. Early in the day something vexes us, we pass it along to someone else and soon our nerves are on edge. The thing to do is to sit down and look at things for a few moments and say, "Steady now, don't get excited. Nothing is wrong, except myself." If we are good natured, we can get the work going smoothly. Just be calm—it will pay you well.

Increased Activity in Vessel Design and Brokerage

As an evidence of the increasing importance of shipbuilding and ship operation in all its branches, the development of the firm of Cox & Stevens, naval architects and engineers, New York, is of interest. This firm has been in operation for some fifteen years and has divided its attention between commercial vessels and pleasure craft. During the past six years the volume of its business has increased to such an extent that additional space has become necessary, where its designing work could properly be carried out. The main office of the firm is still at 15 William street, New York, where vessel and yacht brokerage is conducted and where the members of the firm transact their business, but a new office has been established in the Terminal building at Borough Hall, Brooklyn, which is within fifteen minutes of New York via the subway, where the designing office and drafting room are now located.

Designing Department

This arrangement has been in force for several months and is found to work well. As a result, the professional work proceeds under admirable conditions and without interruption, and, in addition, owing to the space available in the Brooklyn office, a large additional force of draftsmen can be put on at any time to take up special or rush work. Highly qualified men are in charge of the various branches of the work, which are under separate management, so that the various departments are kept separate, the entire organiation as a whole being under one control.

In the early days of its activities Cox & Stevens was perhaps best known in connection with yacht design and yacht brokerage, which departments have always been operated at high efficiency, the volume of business in these branches equalling, if not exceeding, that of any other similar organization. Many well-known and successful pleasure craft, including seagoing yachts, fast express turbine yachts, house boats, motor boats and sailing vessels, have been built from their designs. Subsequently it developed that there was a larger field in the design and superintendence of construction of commercial vessels, and the firm has given an increasingly large portion of its time to this work, without, however, in any way neglecting the yachting field.

Many types of commercial vessels have been designed by them and built under their supervision. These vessels, of both wood and steel, include sailing vessels, auxiliaries, barges, dredges, towboats, river craft, steamers, motor vessels and tankers. The submarine tender *Fulton*, the first full Diesel-engined motorship in this country, was designed by this firm, as well as some of the earliest geared turbine and motor-engined tankers.

Consulting Engineering Work

Cox & Stevens not only act in the capacity of naval architects and engineers for new construction, conduct an active brokerage business, are consulting engineers for several steamship companies, looking out for their floating equipment and superintending their new work, but act in an advisory capacity for a number of shipbuilding companies, placing at the disposal of these companies their designing staff for special problems. This they can readily do without interfering with their routine work on account of their large staff and excellent quarters.

Among the most important recent undertakings that this firm has executed or is now in process of handling may be mentioned: forty auxiliary schooners, twenty steamers

Fig. 1.—Conference Room

Fig. 2.—Entrance Showing File and Consulting Rooms

Fig. 3.—Corner of Drafting Room

Fig. 4.—Drafting Room

and thirty-eight mine sweepers for the Foundation Company, twenty trawlers for the East Coast Fisheries Company, one hundred and twenty-four steel vessels, including towboats, self-propelled barges and barges without power for the United States Railroad Administration, the superintendence of new construction for the Aluminum Company of America, including two steamers, two ocean-going barges and a number of river craft, the superintendence of two 10,000-ton steamers for the Shawmut Steamship Company, the rearrangement as passenger vessels and the conversion to oil burning from coal of several large steamers for the Shipping Board, and the design and superintendence of construction of the largest Diesel-engined yacht that has yet been built in this country.

Financial Advisers

In addition to their strictly professional work, Cox & Stevens have confidential relations with a number of banking houses interested in shipping investments, and in this capacity find a considerable field for their activities, as such bankers naturally require responsible advice before concluding their negotiations.

The history of this firm shows that there are remarkable possibilities in the field in which they operate, provided a good organization is maintained and work is done upon the basis of giving satisfaction to those for whom the work is being done.

Unfinished Waterway Programme

Ten years ago Congress adopted a general plan for the improvement of the main waterways of the Mississippi valley. The original plan provided that this work should be completed in ten years, but now that the time is up the work is not completed.

The main lines of river transportation embodied in the original plan comprised the routes from Pittsburgh, St. Paul and Kansas City to New Orleans by way of the Ohio, the Mississippi and the Missouri rivers. These main lines are fed by many tributaries which should be improved as soon as the main channels reach such a condition of service as warrants their further expansion. Part of this work has been accomplished and the remainder could be completed in three years at a total cost of less than \$50,000,000 (£10,250,000).

New Appropriation Needed

In view of what has already been accomplished and the possibilities which may be developed, it would be a short-sighted policy not to complete the ambitious programme of inland waterway improvement which was begun a decade ago. A new appropriation, small as such appropriations go, is needed for the next year's work in bringing this project to completion, and immediate steps should be taken to get the necessary legislation through Congress to accomplish this purpose.

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Why Beat About the Bush?

JUST when Congress should be shaping up a definite, clearly defined plan for dealing with the merchant marine, the Senate committee on commerce is being swamped with opinions and suggestions from interests both directly and remotely concerned with the question. Consequently, instead of unity of thought or purposeful direction in its deliberations the committee is forced to deal with a mass of ideas varying so widely that in some cases it is almost impossible to reconcile the differences. Under these conditions any immediate satisfactory settlement of the problem seems to be out of the question.

Long ago Congress made it plain that when the shipp'ng interests decide on just what they want and make their desires known with some degree of unanimity, proper action will be taken. Never before was there such a splendid opportunity to place the shipping interests of the country on a sure footing for future development along lines in accordance with sound principles and equitable relations with the business and transportation interests of the country. But Congress, with all its faults, cannot be blamed for delays and inaction, if the people directly interested cannot come to some sort of agreement as to what measures will be best for their business and for the country at large.

Foreseeing the difficulties, if Congress were left to coordinate the wide differences of opinions which were certain to be encountered in a case of this kind, the National Merchant Marine Association was formed months ago by the interests most directly concerned in the future of the merchant marine and therefore best qualified to determine a feasible policy for its development. In due time this association formulated a policy proposing a definite method of disposing of the government-owned vessels and establishing under private control passenger and freight service to such countries as appear to offer the best opportunities for the expansion of our foreign commerce. The recommendations offered by this association have had the indorsement of practically all interests definitely concerned in the matter, and it is safe to say that they represent the consensus of opinion of the country at large.

Just what Congress asked for has been done. But, in spite of this, the question seems likely to become involved in a long, vexatious and costly delay which will upset business and play into the hands of our competitors in the overseas carrying trade. Why beat about the bush when so much is at stake?

Progress of American Shipbuilding

SUPPLEMENTING the figures published in our last issue showing the delivery of over six million deadweight tons of merchant ships to the Shipping Board by American shipbuilders in 1919, we are now able to give complete returns from the Bureau of Navigation, Department of Commerce, showing the number and tonnage of merchant vessels built in private American shipyards last year and officially numbered for American shipowners. According to these figures the total output of American shipyards for the calendar year 1919 consisted of 2,338 merchant vessels of 4,213,891 gross tons for American owners, and 25 vessels of 44,250 gross tons for foreign owners, making a total output of 2,363 vessels of 4,258,141 gross tons for the twelve months. As compared with the output in 1918, this shows an increase of 481 vessels and 1,536,860 gross tons. Of the 1919 output, 916 vessels of 3,569,824 gross tons were built of steel, an increase of 434 vessels and 1,699,465 gross tons over 1918.

Just what this year's record output of shipbuilding means to the standing of the United States as a maritime nation is perhaps better shown by a glance at the figures for the new American merchant marine in operation at the beginning of the current year. On January 1, 1920, the American merchant fleet consisted of 28,731 vessels of 15,441,786 gross tons. This is double the total merchant shipping which the United States possessed before the war, and is, as a matter of fact, nearly as large as the merchant fleet of Great Britain. As compared with the British merchant marine, however, which is almost wholly engaged in foreign commerce, the American merchant fleet is divided between foreign and domestic service in the proportion of about three to two—that is, our overseas fleet totals approximately 10,000,000 tons, or about three-fifths of the amount of British tonnage engaged in foreign commerce.

Having thus doubled our merchant fleet in the past two years and come into the possession of over one-quarter of the steel steam tonnage of the world, interest naturally centers in the prospects for future production in American shipyards. As a matter of fact, about a million gross tons of steel steamers, independent of those being built for the Shipping Board, are now under construction in the shipyards of the United States, and with one exception all of these vessels are for American owners. The fact that the tonnage now actually building to the order of private enterprise is practically equal to the full decrease

in the work of a similar type for the Shipping Board, brought about by the completion of government contracts, gives good promise of the future of American shipbuilding on its present basis.

If further encouragement as to the future of the American shipbuilding is needed, it can be found in a statement just issued by the Atlantic Coast Shipbuilders' Association, which shows that the volume of merchant tonnage ordered by private interests since the signing of the armistice practically equals the volume of the entire seagoing shipping of the country at the outbreak of the war. Furthermore, the merchant tonnage now under construction for private ownership is seven times as great as the ship construction of all types under way in this country at the beginning of hostilities. Summaries prepared from the official records of the American Bureau of Shipping and Lloyd's show a gain in the output of merchant tonnage in American yards for the past month of nearly 175,000 gross tons. Since last September the gain has amounted to more than 625,000 tons. How steady the increase has been is shown by the total under construction for the past four months. In October it amounted to 347,343 gross tons; in November, 550,714 gross tons; in December, 805,147 gross tons, and in January, 977,488 gross tons.

A feature of the returns is the marked demand for tanker tonnage. In October last, according to the statement of the Atlantic Coast Shipbuilders' Association, the excess of freighters over tankers in course of construction for private account in American yards was 59,000 gross tons, but today tanker tonnage leads. While the freighter tonnage being built for the Shipping Board is at present considerably in excess of that on the ways for private account, the reverse is the case in relation to tankers, the total under construction for the government being about 274,000 gross tons, as compared with 476,000 tons building to private order. Standard Oil companies lead in the amount of this type of tonnage being built, but more than 325,000 tons of the 476,000 tons total is for other concerns.

In the amount of tonnage being constructed, the Federal Shipbuilding Company, Kearny, N. J., leads the way with 35 vessels of 208,276 gross tons, composed of 26 freighters aggregating 156,276 tons, 5 tankers totalling 50,000 tons, and 4 barges of 2,000 tons total. The Bethlehem Shipbuilding Corporation follows with 24 vessels of 184,888 tons, of which 23 are tankers aggregating 177,738 tons and one an ore carrier of 7,150 tons. The Sun Shipbuilding Company has under way 13 tankers of 91,017 tons and a freighter of 7,700 tons. The largest amount of freighter tonnage being built for one concern consists of 20 vessels aggregating 120,000 tons for the United Steel Corporation.

Another gratifying sign is the continued increase in the number of yards engaged on private contracts. In October these totalled 27; in November, 31, and in December, 38. For January the figure has risen to 43. Confidence of American shipbuilders that there would be a market for American steel tonnage well beyond present demands is most strikingly shown in the way in which builders have been taking over for their own account contracts cancelled by the government. About 175,000 gross tons of vessels are now being built in this way, seven yards having taken up contracts for 35 freighters totalling 142,158 tons, and three yards continuing work on 5 tankers aggregating 32,000 tons. Of the 188 vessels of various types under construction in American yards today, only one is building for foreign account, so that American shipbuilding is practically a one hundred percent American supported industry.

Superheated Steam

In comparing the efficiencies of the various types of engines and the efficiencies of propulsion of the different combinations as applied to the actual work of propulsion, Rear Admiral Dyson, in a paper recently published in the *Journal of the Society of Naval Engineers*, states that where superheat is applied, even in small amounts, the advantage derived is of such great amount as to be worthy of the most serious consideration. In one case cited the gain in water consumption at 30 percent full power, with 41 degrees superheat, is 6.7 percent; at 50 percent of full power, with 46.3 degrees superheat, the gain has risen to 7 percent; at 100 percent of full power, with 58.6 degrees superheat, the gain is 8 percent. In general, it is stated that an average rough figure for the gain due to superheating may be taken as one percent for every ten degrees of superheat.

While the advantages of superheated steam are fully recognized by the navy, in merchant practice in the United States there seems to be an attitude of stubborn resistance towards its use, except in the case of low-degree superheaters, which in effect are steam dryers. Abroad, however, rapid strides are being made in the adoption of superheated steam in merchant vessels, and this chiefly in the direction of superheating to 150 or 200 degrees. Convincing evidence of this is given in data published elsewhere in this issue. Here it is shown that at the higher rates of engine power the saving per degree of superheat increases, although the degree of superheat is not increased to a marked extent. Due to the tendency towards higher-powered vessels in present merchant practice, this saving is one of the excellent reasons why highly superheated steam is in such common use abroad and explains its rapid increase in popularity, as evidenced by more than 2,000 vessels in operation or building which are so equipped.

The economies of fuel resulting from the use of superheated steam are of such importance in these days of keen competition for the supremacy in overseas trade that this valuable accessory to the marine steam power plant cannot be ignored. Modern designs of superheaters present quite a different problem from the earlier experiments which aroused prejudice and antagonism toward this development. With the present successful designs of superheaters there seems little excuse for the deep-seated prejudice against superheated steam.

The Metric Fallacy*

UNDER the above title, Frederick A. Halsey, Commissioner of the American Institute of Weights and Measures, has published a book of over 200 pages containing the results of an investigation of the claims made for the metric system, and especially of the claim that its adoption is necessary in the interest of export trade. In the United States little attention would probably be given to the idea of adopting the metric system, if it were not for the fact that a certain amount of propaganda has been carried on recently throughout both the United States and Great Britain appealing to all classes of people for the support of a movement to secure legislation by the United States Congress and the British Parliament, making the use of metric weights and measures compulsory and prohibiting the use of the English weights and measures now established. Since this movement has been started there has been a too ready acceptance of its arguments by a certain class of newspapers and publications, and by the unthinking public, with the result that steps have been taken to introduce in Congress measures to compel the adoption of the metric system.

The argument for the adoption of the metric system, it is pointed out by Mr. Halsey, is based upon the tacit assumption that it is a simple matter for a country to change its weights and measures; once one has accepted that assumption it is but a short step to the conclusion that those countries which have made the experiment have succeeded; and then another short step to the conclusion that the experiment can be carried out successfully in this country. As it is on this argument, or theory, that the entire metric case is based, Mr. Halsey shows what actually has been accomplished in twenty attempts to bring about this change in other countries, most of which date from about the middle of the last century. With but one exception, the result has been grotesque failure, while in no case has the attempt to retire old units been successful.

Taking up the use of the metric system in export trade, the statistics show that 82 percent of American exporters to metric countries do not use the metric system at all in production, while 14 percent use it partially and only .3 of 1 percent really use it exclusively. The conclusion drawn from the investigation is that the commerce of the world is conducted by the English system and that the current phrase, "the international metric system," is nothing but a pretext and a sham.

In the commercial use of the system the results are equally striking. According to the statistics compiled in this book, it is shown that 1.6 percent of American exporters use the metric system in response to a commercial need, but that not one uses the system exclusively. While 38 percent of the exporters make some use of it in shipments, because they are compelled to do so by the laws of foreign countries, these uses, as a matter of fact, show how trifling is the influence of such laws when confronted by the customs of commerce.

In Great Britain, where similar attempts have been made to gain a foothold for the metric system, the subject has been given very careful consideration by special Parliamentary committees, and the result in each case has been a failure to recommend the compulsory adoption of the metric system. The British committee, representing the shipbuilding and shipping industries, stated that "so far as shipbuilding and marine engineering are concerned, we see no reason for the change. That part of the metric system involving the decimal subdivision of time and the right angle is most objectionable, and, if adopted, would most seriously prejudice the interests of navigation."

Before attempting to adopt a new system of weights and measures or change the present system, the outstanding features of the present weights and measures of the world should be considered. In this book they are stated as follows:

1. The universal use of the English system in navigation and sea measurements.
2. The overwhelming preponderance of the English system in manufacture.
3. The overwhelming preponderance of the English system in international trade and commerce, due to the fact that the United States and Great Britain are the chief manufacturing and trading nations.
4. The fact that the forces of trade and commerce have carried the English system to every quarter of the globe.
5. The fact that all the nations investigated use the English system and are perfectly familiar with it.
6. The fact that the people everywhere do not like the metric system and refuse to use it except to the extent to which they are compelled by law.
7. The fact that the attempt to adopt the metric system has been followed by failure after failure.
8. The great similarity of the English and Spanish system, which are substantially identical in structure, their differences being chiefly in the value of units which, in most cases, are practically negligible.
9. The fact that in five countries of Latin America this slight difference in values of units of weight (½ of 1 percent) has led to the general adoption of the English values.
10. The fact that German influence, which, in the past, has been largely responsible for the propaganda in favor of the metric system, will in future be negligible.

All these conditions, it is pointed out, open up a great opportunity for the unification of the weights and measures of North and South America and the British Empire on the basis of the system which is common to all.

Here, says the author, is a simple, sensible, practicable plan for the promotion of the commercial relations of the two Americas and of the British Empire. Nothing, in his opinion, would so promote international trade and assure the dominance of the English-speaking peoples over Germany in industry and commerce. In other words, to promote the English system is to work for the interests of the English-speaking peoples; to promote the metric system is to work for the interests of Germany.

Certainly, without some better arguments than those so far given, there seems little excuse for any attempt to promote the adoption of the metric system in the United States. If for certain industrial or commercial purposes it is found desirable to use the metric system, its adoption for this particular purpose should be optional with the manufacturer or producer concerned. Any attempt to make its adoption compulsory would result only in failure, confusion and vast unnecessary expenditures, the benefits from which would be practically negligible.

* Published by the American Institute of Weights and Measures, 115 Broadway, New York. Size, 6 by 9 inches. Pages, 229. Illustrations, 2. Price, $3, postpaid.

A steering engine is, or should be, a very simple machine, yet it is surprising how many engineers cannot explain how it works. It pays to know all about the engine that steers your ship. Get a catalogue from its makers and read up on the subject.

Feeding a man and feeding a boiler should not be done in the same way. A man takes his food every so often, while the feeding of a boiler should be a "continuous performance" if you want the best results.

When you are on watch, watch.

LETTER TO THE EDITOR

Lake System of Dry Docks

Editor MARINE ENGINEERING:

The writer notes in the December issue, among "Letters to the Editor," a criticism of the above-named system, written by F. W. Erickson, vice-president and general manager of the Marine Engineering & Dry Dock Company of Rhode Island. Carefully considering the points brought forth in the criticism, the writer finds that Mr. Erickson must have misunderstood the way of operating the system in question, else a reference would not have been made to perpetual motion or to lower level chambers.

The system of dry docks evolved by the writer relates simply to dry docks all located at sea level and interconnected by conduits. These conduits serve to transfer water from one dock to another as required. With this arrangement in view, it is self-evident that the pumping step heretofore necessary can be eliminated in a large degree. Also can the time required to empty a dock be reduced to a minimum.

May the writer, for the sake of explanation, take two dry docks, No. 1 and No. 2, of same size, located both at the sea level and interconnected by conduits? In each of these docks is a ship repaired and ready to go out, but so far both docks are empty of water. The operation of this system is now as follows:

Step No. 1.—Dock No. 1 is filled with water and the ship goes out, after which the sea gate is closed.

Step No. 2.—The valves in the conduits are opened. It is now evident that the water from No. 1 dock will flow into dock No. 2 until a common level has been reached in both docks.

Step No. 3.—The valves in the conduits are now closed and the remaining water in dock No. 1 is pumped out. Dock No. 2 is meantime filled from outside water to sea level.

Step No. 4.—The ship in dock No. 2 goes out and then the sea gate is closed. Meantime the blocks in dock No. 1 are set for the next ship.

Step No. 5.—Now the valves in the ducts are opened and half of the water in dock No. 2 will consequently flow into dock No. 1.

Step No. 6.—The valves are then closed again and the remaining water in dock No. 2 is pumped out. Meantime dock No. 1 is filled from outside water to sea level.

Step No. 7.—A new ship for repair is now floated into dock No. 1, after which the sea gate is closed. Meantime the blocks in dock No. 2 are set for a new ship.

Step No. 8.—When this is done, the valves in the ducts are opened and water from dock No. 1 flows into dock No. 2 until a common level is reached.

Step No. 9.—The valves are hereafter closed and the remaining water in dock No. 1 is pumped out. The ship in this dock is now docked. Meantime dock No. 2 is filled with outside water to sea level.

Step No. 10.—Sea gate for dock No. 2 is opened. A new ship is floated into that dock, after which the sea gate is closed. The operation is finished by pumping all the water out from dock No. 2. Both new ships for repair are now docked.

In common practice at present it would be necessary when docking these two ships to pump out all water twice from each dock, thus involving 100 percent of pumping. Through the system in question the pumping step is reduced to 62 percent. If three docks were used in the operation the pumping step would be reduced by at least one-half, or 50 percent. Again, in case one dock should be much smaller than another dock in the system, it could happen that all water from the smaller dock twice could be emptied into the larger dock. No pumping from the smaller dock would in that case be necessary when docking a new ship for repair in that dock, thus accomplishing a 100 percent saving in pumping. The larger dock would, of course, be pumped out twice before a new ship for repair could be docked, in case no other dock in the system is at hand for combined operation.

In some instances, again, it may occur that the water discharged from a smaller dock will be insufficient to fill a larger dock to a depth sufficiently great to interfere with the repair work which is proceeding upon a vessel in that dock. Thus, for example, a large vessel, which has had its shell plates repaired and the work being done is well up on the body of the vessel, the water admitted from a small dock would not rise sufficiently to interfere with the work being done.

It will, of course, be understood that the best results from the use of the system in question are attained by careful planning of the work to be done on any vessel and the time of receiving and discharging the vessels. This can very well be done. The system in question points only toward a reorganization of docking of vessels. The way of docking at present is more or less an inefficient one.

Concerning loss due to leakage through the interconnecting ducts, the writer may here refer to the Panama Canal, where the parallel locks are similarly interconnected as the docks in this system. The valve arrangement in the Panama Canal is satisfactory, and satisfaction can consequently be reached also in this case.

Regarding the expense of installing ducts between already existing dry docks, that expense will soon be outbalanced by the increased efficiency of the dry dock plant. When installing the conduits, only one dry dock at a time would have to be out of operation, or excavation could also very well be done meantime when ship repair work is going on in the dry docks. Concerning projected dry docks, the additional expense of installing interconnecting ducts will be very small in proportion to the cost of building the dry docks proper.

The cost of operating this system will be only a part of the cost of the present operation of dry docks. The pumping step is considerably reduced, and the transfer of water from a fitted dock to an empty one by gravity becomes merely a matter of opening and closing the proper conduits. Electricity can be used for this purpose.

The disadvantage caused by interdependence between the dry docks in a plant is only apparent. It is evident that in a large docking system, consisting of, say, three or more dry docks, a considerable number of combinations are possible, where the docks are interconnected, and it is possible so to schedule the operations that one dock may always be flooded and in receiving condition, while others are simultaneously ready to discharge a vessel or vessels. At the same time it is self-evident that in a dry dock plant, where interconnecting ducts are installed, these ducts do not need to be used in cases when the use of them would be inconvenient. Pumps are always at hand to do all the work in such instances. The system will be found most convenient in cases when a dry dock plant is working on short orders, i. e., when dockings of ships are done for inspection, changing of propellers, painting of bottoms, etc.

There is no reason why the dry docks in a plant should be separated when they can be interconnected.

Philadelphia, Pa. JOHN LAKE.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Notes on Joining a New Steamer

The chief and first assistant engineers are, as a rule, appointed after a vessel is launched and is lying alongside the fitting-out wharf for machinery installation. As the general plans, materials, etc., have, of course, been approved by the owners, United States inspectors and Lloyds or other underwriting society, the engineers are more concerned in the actual workmanship with which the vessel is constructed.

The double bottoms and deep tanks, which have been tested when the ship was on the slip, are now ready for final cleaning and to be covered with preservative composition. They should be carefully examined and the height taken at sounding pipes. The pipes are improved if they are perforated inside the tanks to allow a free circulation of oil or ballast in the pipe.

In a recent case a steamer ran short of fuel and was towed to port. The deep tanks were constructed on top of the double bottoms, the bilges being included in the tanks. As it was found that the sounding pipes extended to the bottom of the bilges and showed a false depth of nearly four feet in each tank, the engineer's license was suspended.

As all suction pipes are carried through the double bottom, it is important that they be in perfect condition before they are closed up and filled with fuel or ballast. They should be well secured with hangers and kept well clear of the framing to prevent chafing.

Pipes extending from bulkhead to bulkhead in the tank should have a 90-degree offset and not be in a straight line, to prevent any strain when the ship is working in a sea-way.

Examine all pipe flanges and bulkhead fittings, for it is not unusual to find them broken. Moreover, the bolts and gaskets are sometimes missing.

Trace pipes to their manifold valves and make sure that they are correctly tagged. Do not depend on the blue prints.

Deep tanks and peaks are fitted with a valve on the bulkhead inside the tank. To prevent flooding of other compartments in case of accident to the suction line or manifold, an extension rod is fitted from the valve stem through the tank top to the deck. Pay close attention to this rod; it should fit securely on the valve stem and have a rigid guide bracket every eight feet. A thick washer fitted with a tap screw, secured on the rod under the tank top fitting, will prevent the rod unshipping when operating the valve.

The double bottoms and deep tanks are very important to the chief's comfort, if he knows that they are in perfect order. Fuel in a tank with defective suction might as well be in the oiling station ashore—in fact, better, for the tank would then be empty and so nearer to being ready for repairs.

After the tanks are covered with composition, make a final examination, for sacks, paint brushes and old buckets are liable to be left behind. Get the tank doors on at once and fill in around the edge of the plate with cement. In the writer's experience on a new steamer, taking oil into a midship deep tank "over the top"—that is, through the manhole—the steward was unpacking his glassware and three sacks of excelsior found its way into the tank, and we, two months afterwards at sea, pulled it out of the manifold valve.

Boilers are lowered into place with all fittings attached. They are built under close supervision and the engineers will probably not see them until they are on the wharf. Feed, surface and bottom blow, steam and escape pipes are connected up. These pipes should not be sprung into place, but come fair flange to flange and hole to hole. Copper pipes are fitted with hangers lined with sheet lead, giving a snug fit for the pipe, which should not pinch.

The delivery pipe from the injector should come into the feed pipe with an easy sweep and not into a tee. It is good practice to have as direct lines as possible on the injector.

After the boilers are tested, brush down and clean out thoroughly; fill with fresh water, and, to a 20-ton boiler, add 100 pounds soda ash. Light a wood fire in one furnace and boil out. A wood fire prevents forcing the boiler. If it is possible to get clean salt water, this should be used to boil out the boiler, but it is difficult to get at the average shipyard.

During the time that the boilers are warming up, scrape the shell and cover with two coats of fish oil to prevent rusting.

The lagging blocks should be packed closely and finished with asbestos cement. Pay particular attention to the lagging around the bottoms of the boilers. This is a slow and difficult job and is sometimes scamped. It is interesting to watch the difficulty in warming up a boiler before lagging, and the ease with which it is accomplished after it is properly lagged.

After the lagging has dried out, galvanized sheeting is fitted over it. The sheeting around the bottoms of the boilers is worth attention. In some jobs the lagging is made portable over the combustion stay ends, as this allows a frequent examination of this important part of the boiler.

After the boilers are well boiled out (the writer has found three days sufficient) they should be pumped out, thoroughly scraped and wire-brushed, and kept dry until they are required for the dock trials. Replace the manhole covers to keep out dirt.

Examine the studs securing the breeching to the shell. Sometimes they are broken, and it is nobody's business to report it. The breeching should fit closely around the boiler shell and packed with ⅛-inch asbestos sheet to prevent air leaks.

The forced draft air ducts are a favorite place to stow template sheets and other rubbish. The writer has traced

several complaints of bad draft to template sheets blanking the air heating tubes.

The lagging on steam pipes should be portable over the flanges to permit examination of the pipe at the back of the flange, as any defect is almost sure to be found at this place.

Whistle pipes are connected directly to the boiler and a straight lead will keep them drained. This also prevents freezing in cold weather. Leading the pipe to the whistle inside the stack casing is good practice.

In installing the engines, the tail and main shafting being lined up, the rivet points on the thrust block stool are flushed and the thrust block and shaft lowered in place. The after coupling flange should be trued to the forward flange by means of steel wedges under the thrust block. Chocks are then fitted, holding down bolt holes are drilled and bolts hammered down solid. Check up the couplings for fairness after all is finished.

The engine bed plate is fitted in the same way, taking care that the rivet points are flushed. Turbine engines are fitted in a similar way, the reduction gear being first lined up and secured, then the turbine lined to the reduction gear. Alternate holding-down bolts in thrust and engine beds are machined and made a driving fit for the holes, which are reamed true to size.

On some jobs end chocks are fitted, to prevent lateral motion of the bed plates. The fitting of chocks requires skill to make a good job, but generally any man is good enough, so close attention should be paid to it. Each chock must have a good face bearing and a driving fit. Try each with a thin searcher and tap with a testing hammer.

Everything depends on the engine and shafting being in line and having a good solid foundation.

As the engines are assembled all working parts should be covered with clean canvas or burlap and securely lashed. When coupling up piston rods and other tapered fits, use mercurial ointment instead of oil. They will come adrift at any time without heating.

In the case of the auxiliary machinery the stool plate of pumps is improved by flanged edges to form a pan. Fitted with a drain pipe to the bilge, it keeps the engine room platform clean. There should be enough space around the pump for overhauling and for withdrawing the rods.

Pipe connections that are fitted fair, instead of being sprung into place, save hours of work and trouble at sea. Gaskets of well-laid pipe lines do not give any trouble.

Pipe hanging is another job that is not in demand among shipyard men. It is neglected in most yards, and nothing is more annoying than loose and vibrating pipes. Hangers should be spaced about nine feet apart.

Pumps, as delivered from the makers, have rubber gaskets and packing. Any pump that is to handle oil requires fiber gaskets and a packing designed for oil.

The electric plants now installed on new steamers give little trouble. Any conduit pipe exposed to the weather or other dampness should be painted at sleeves and outlets with black japan or enamel. Make sure that the deck fittings are really watertight and that the glass globe is cinched tight against the gasket.

If the steering engine is operated by a telemotor it is important that telemotor and valve lever are in line when the rudder is hard over, as well as when it is amidships. If it is fair when amidships and high and low when the telemotor is hard over either way, this is the cause of many stiff wheels, and also of the wheel not running back to the center.

The foundation bolts of the deck machinery should be accessible. They are sure to slack back in time, when the nuts are sure to be tight.

The dock trial is simply a preliminary running of the machinery when the ship is alongside the wharf, so that any defect may be remedied. Various speeds are run and no data are taken.

On the trial trip, have the settling tanks sounded when the bell rings that the ship is at full speed on the measured mile and again when she has finished. Take the register at the end of each mile, also pressures, temperatures, revolutions and strokes of auxiliaries. A draftsman is generally in charge of the indicating, and he will supply you with a set of cards taken on each run.

The assistant engineers can be usefully employed in observing the actual running of the machinery. Too often they depend on the shipyard crew to detect hot bearings and other defects. This is a good chance to judge an assistant's character and to act accordingly.

After the measured mile the ship proceeds on an endurance run, generally four hours. The fuel should be measured at the start and data taken every half hour, measuring the fuel at the finish of the run.

On the run back to harbor the speed of the ship on the measured mile and on the endurance run can be obtained from the captain, who will probably be interested in how the machinery ran. The data tabulated and averaged give the performance of the ship in ballast without cargo. An oil tanker generally runs her trial ballasted to the load line.

The deep-sea trial is an endurance trial after the ship is loaded and ready for sea. Twenty-four hours is a fair run. The fuel is measured and data taken as in the light trial.

The engineer's industry during the time the ship is in the shipyard will be rewarded by the absence of those small defects that are otherwise sure to crop up.

Oil Fuel.

Trouble With a Generator Set

When Marine Engineering comes aboard, the first thing I do is to look at the front page and read the advertisements. Then I turn to the letters from engineers, as I get a great many good points from them.

We have two electric sets on board. They each develop 15 kilowatts and run at 550 revolutions per minute. The engines are enclosed and are fitted with a forced system of oiling, the only one fit for such high speeds. The engines have been in charge of the chief for over three years and have never given any trouble. In that time the bearings have been taken up but once.

A few weeks ago oil began to run out of the case where the crank shafts pass through the casing, and this made things very messy. It seemed strange to me that both plants should start leaking at the same time. But if one did, why not both?

The chief thought the leak was caused by the packing wearing in the casting which was bolted to the engine bed. This casting was split so the top half could be taken off in order to take out the shaft. Where the crank shaft passed through this casting a recess had been turned and square packing put in it. The casting, bolted to the bed, formed a pocket for the oil to drip into from the crank shaft bearing.

The chief ordered me to take a man and repack the casting. I got an oiler named Girdwood. He had been chief on a tramp steamer, but got to drinking and at last had to go to oiling. He was Scotch, and when not drunk was a very good man. When I got the top half of the casting off I gave it to Girdwood and told him to go and get some new packing while I dropped off the lower half.

He looked at the packing and at the shaft, and in his

Scotch way said that the trouble was not in it. "Where is it " I asked. "I will show you," he answered. Then he soaked out all the oil in the pocket with some waste and unbolted the lower half of the casting from the bed. There was about an inch of muck in the bottom of the casting, and Girdwood pointed to two holes drilled through the bed, leading from the pocket into the bed. These he cleaned out, as well as the casting, and put it again in place. When we started up the set there was no more leakage.

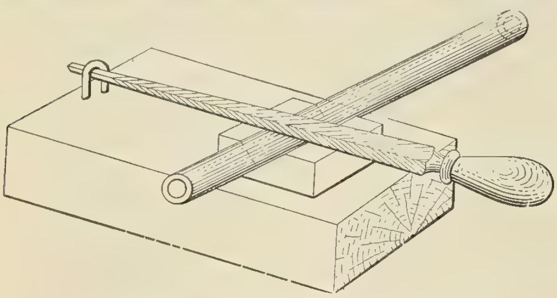
This goes to show that sometimes we do not look quite far enough for the real cause of trouble.

New Orleans, La. A. Bruce Hunt.

Gage Glass Cutter

When it is necessary to cut a gage glass to different lengths and there is not a regular tool available for the work, a very satisfactory substitute can be made from a three-cornered file, a wire staple, and a block of wood, as shown in the accompanying sketch.

Drive the staple into the board; cut a V-block in which to rest the gage glass. Put the point of the file under the

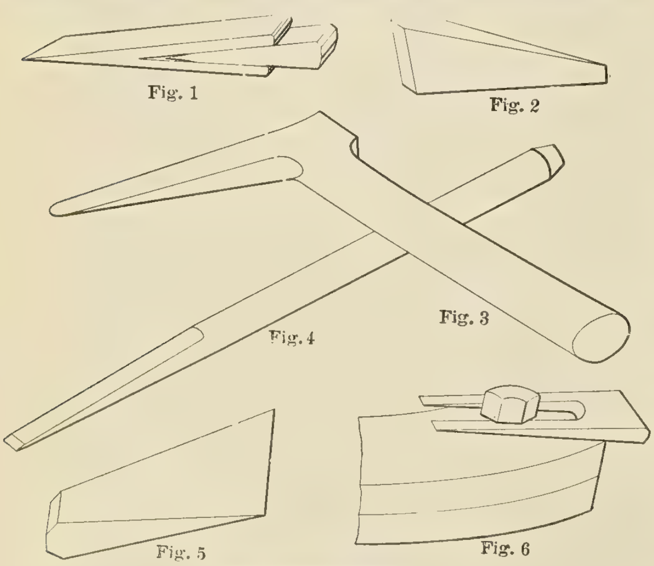


Improvised Tool for Cutting Glass Tubes

staple and press the edge of the file down on the glass and revolve the glass until it is marked. Remove the glass, heat it at the mark with a match and quickly plunge it into cold water. It will break off clean. Water Tender.

Useful Wedge Tools

All mechanics and engineers know the value of wedges as tools in repair work, but I have often noticed that even



Six Useful Wedges

with this knowledge many fail to provide themselves with an assortment of wedges that would make it easier to perform that work which calls for a wedge.

I have drawn herewith a few sketches showing some of the types of wedges that I have found most useful in my work and pass them along in hope that others may also find them of value. Fig. 1 is of the combination solid and split wedge for use in places where it is only possible to enter a thin wedge and not convenient to enter another thicker one without first removing the thin one. The use for such a wedge as this is obvious.

Fig. 2 shows a two-way taper with narrow starting face. Figs. 3 and 4 show handled wedges, which are useful in a wide range of work. Fig. 5 is another style of double type wedge called a fan-face wedge. Fig. 6 illustrates a slotted wedge and its handy use for removing rust-bound bolts. Assistant Engineer.

Method for Testing Evaporator Water

Calling on a friend of mine not long ago I found him working around his evaporators. Alongside the evaporators I noticed what, upon inquiring, I found to be a quick method of testing evaporator water.

On returning to my vessel I made an outfit similar to the one I saw, and, after experimenting with it, found it

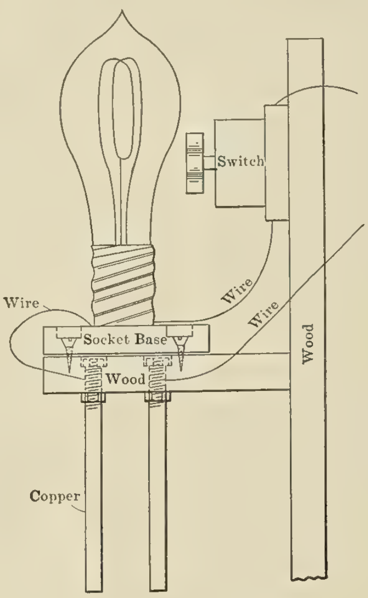


Fig. 1

to be very accurate. The only material that is required to make it is used on all electrically lighted vessels.

A porcelain electric light socket into which an electric light is screwed is fastened to a wooden base. This base may be attached to a convenient bracket. Through the base are secured two ¼-inch copper rods 3 inches long and about ⅜ inch apart, which are connected to the ship's current.

The water to be tested is poured into a glass or other receptacle made of non-conducting material. The two contacts are then inserted into the water, which, if pure, will not allow the circuit to be completed and the lamp will remain darkened. If the water contains as little as 0.3 grain of salt the globe will light. The saltier the water the brighter the light will burn. The sketch, Fig. 1, illustrates the method used to make this convenient bit of apparatus. "Ideal."

Dirt in a boiler or in the bearings of your engine is as bad for both as is dirt in your own system. You would not drink dirty water. Why give it to your boiler to drink?

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

De-aeration of Boiler Feed Water

Q. (1031).—The trend of modern marine engineering practice is towards the elimination as much as possible of all air from the boiler feed water. It occurs to me that several years ago I read an account of a boiler explosion which was then attributed to the entire lack of air in the boiler water. So far as my memory serves me the instance was a tug boat which had foundered outside the mouth of the River Scheldt. The vessel had lain at the bottom of the sea for some time and was subsequently raised; then men were sent on board to raise steam on the boiler, the original water still remaining in the boiler. On the next day, before the vessel started to leave the spot, she blew up.

So far as I can recollect, the cause of the explosion was assigned to the supposition that the air which had been held in the boiler water had combined with the metal of the boiler shell to form ferrous oxide, leaving the water entirely de-aerated. Then after the fires had been set away some hours the water, having been heated beyond the boiling point, had then suddenly passed into steam with explosive force, shattering the boiler and vessel.

I can find no data supporting this view, and I shall be glad if you have any information bearing on the subject. W. I. E.

A. (1031).—To the writer it would seem that whether the boiler contained merely water and its vapor, or water, its vapor and the slight amount of air ordinarily present mattered little. An engineer would naturally remove some of the water before getting up steam, and doing this would be likely to cause air to combine with the water and occupy the steam space together with water vapor.

The statement that the boiling water burst suddenly into steam would seem to indicate that "retarded ebullition" was blamed for the explosion, i. e., the water was superheated about the heating surface and burst instantaneously. This, according to Stromeyer, is impossible in a closed boiler (see Stromeyer's "Marine Boiler Management," 1914, page 57, which volume gives some interesting cases of boiler corrosion).

A plausible explanation of the case cited is that the stayrods or shell had corroded locally; a safety valve may not have been in working order. This would provide ideal conditions for an explosion. Air or cold salt water separately are not as bad corrosive agents as the two in combination.

Another theory might be based on the likelihood of an insulating scale being formed over some part of the furnace or combustion chamber. This would allow that portion to be overheated, causing it to buckle and rupture.

The illustration given by the questioner is a most interesting one. It would be well to give more publicity to boiler accidents which have occurred in the past. In England the Institute of Marine Engineers, the Board of Trade and the classification societies take up all accidents and assign causes.

Lock Nuts

Q. (1024).—Would you kindly, in your next issue, settle an argument regarding the proper position of lock nuts. I have always placed them as shown in Fig. 1, but *A* tells me that when a lock nut is tightened the stress on the large nut, Fig. 1, will be entirely removed. I have made up my theory as to what takes place when the nuts are tightened, but would be very thankful if you would settle the argument G. J. L.

A. (1024).—*A* is right; but it is undeniable that lock nuts are commonly placed as in Fig. 1, which illustrates their action. Fig. 2 shows the proper method of applying them. Now the purpose of using two nuts is to prevent vibration from causing them to slack off. Unless the outer nut is screwed up enough to take a good portion of the load from the inner one it will tend to slacken up and thereby be of no service. If the inside nut is screwed up fairly tight and the outer made very tight, the effect shown in Fig. 1 will be produced. Considering the threads of this bolt, it is seen that the inner nut acts against the outer, and therefore the latter takes not only the bolt load but also that due to the inner one. Hence the outer nut should be the thicker. Due to the trouble of screwing a nut less than 0.7*d*, the standard wrench thickness, as well

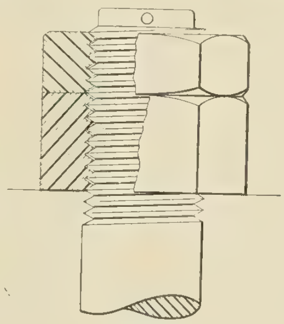


Fig. 1

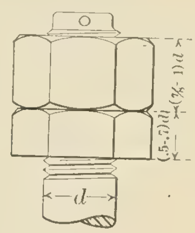


Fig. 2

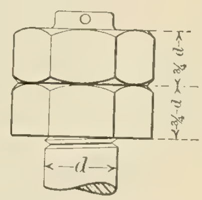


Fig. 3

Sketches Showing Proper and Improper Positions of Lock Nuts

as through force of habit, the thinner nut is rarely placed in its right position. To obviate this tendency it is advisable to make both nuts of the same thickness, say ¾*d*. Lock nuts are used for auxiliary machinery, the valve gear, link rods and levers of reversing gear, thrust shoes, etc.

When you order spares and they come aboard, take time to measure them up with great care. A little "out" can be corrected in a few moments in the shop, while it may take hours to make the fit at sea. It will pay, whenever possible, to do the inspecting of spares in the shop where they are made. More care will be taken if the foreman knows that someone is to inspect the work.

A piece of emery cloth thrown on top of a bunch of waste in a drawer or closet is a sight often seen. That is as poor a combination as anyone can make, yet it would be a safe bet that aboard your ship or in your shop this absurd condition is to be found time and time again. Take a look, Chief, and you, Mr. Foreman, right now and see if it is not so.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

2,338 VESSELS BUILT IN 1919 BY PRIVATE AMERICAN YARDS

All Were for American Owners, Aggregating 4,213,891 Gross Tons—52 Vessels, of 44,250 Gross Tons, Built for Foreign Owners—Big Increase Over 1918 figures

The Bureau of Navigation, Department of Commerce, reports that during the calendar year 1919 private American shipyards built 2,338 merchant vessels of 4,213,891 gross tons, which have been officially numbered for American shipowners, and accordingly are now in trade or about to engage in trade. American shipbuilders also built 25 vessels of 44,250 gross tons for foreign owners, making a total output of 2,363 vessels of 4,258,141 gross tons for the 12 months.

During the calendar year 1918 the corresponding output was 1,834 vessels of 2,622,588 gross tons for American and 48 vessels of 98,693 gross tons for foreign owners, a total of 1,882 vessels of 2,721,281 gross tons.

Of the 1919 output, 916 vessels of 3,569,824 gross tons were built of steel, an increase of 434 vessels and 1,699,465 gross tons over 1918.

The following details of vessels built and officially numbered in the United States in 1919 are reported by the Bureau of Navigation:

Kinds	Atlantic and Gulf		Pacific		Great Lakes		Western Rivers		Total	
Wood	No.	Gross Tons	No.	Gross Tons	No.	Gross Tons	No.	Gross Tons	No.	Gross Tons
Sailing	97	102,550	6	9,736	1	1,946	....	....	104	114,241
Steam	119	178,607	85	221,952	34	9,732	15	1,886	253	412,177
Gas	381	27,245	294	27,584	66	1,151	83	1,506	824	57,486
Unrigged	136	52,028	68	6,852	8	785	29	498	241	60,163
Total	733	360,439	453	266,124	109	13,614	127	3,890	1,422	644,067
Metal										
Sailing	4	6,653	....	......	....	......	....	....	4	6,653
Steam	*394	1,848,230	197	1,174,743	212	508,574	5	1,507	808	3,533,054
Gas	12	4,877	....	......	7	74	2	44	21	4,995
Unrigged	†41	12,142	1	348	‡38	10,969	3	1,663	83	25,122
Total	451	1,871,902	198	1,175,091	257	519,617	10	3,214	916	3,569,824
Totals										
Sailing	101	109,212	6	9,736	1	1,946	....	....	108	120,894
Steam	513	2,026,837	282	1,396,695	246	518,306	20	3,393	1,061	3,945,231
Gas	393	32,122	294	27,584	73	1,225	85	1,550	845	62,481
Unrigged	177	64,170	69	7,200	46	11,754	32	2,161	324	85,285
Grand total	1,184	2,232,341	651	1,441,215	366	533,231	137	7,104	2,338	4,213,891

* Includes 4 vessels of 10,635 tons built of reinforced concrete. † Includes 11 vessels of 3,356 gross tons built of reinforced concrete. ‡ Includes 7 vessels of 2,133 gross tons built of reinforced concrete.

As compared with the foregoing table the following are the details of the vessels built and officially numbered in the United States in 1918:

Kinds	Atlantic and Gulf		Pacific		Great Lakes		Western Rivers		Total	
Wood	No.	Gross Tons	No.	Gross Tons	No.	Gross Tons	No.	Gross Tons	No.	Gross Tons
Sailing	77	59,428	19	14,325	....	......	....	....	96	73,753
Steam	108	183,550	128	324,351	13	3,540	15	1,523	264	512,964
Gas	242	24,425	309	50,048	43	660	66	1,223	660	76,356
Unrigged	209	78,303	67	7,596	25	2,550	31	707	332	89,156
Total	636	345,706	523	396,920	81	6,750	112	3,453	1,352	752,229
Steel										
Sailing	4	4,092	....	......	....	......	....	....	4	4,092
Steam	132	601,698	*155	871,561	177	389,853	2	335	466	1,863,477
Gas	3	550	....	......	....	......	‡4	52	7	602
Unrigged	2	1,340	†1	325	2	553	....	....	5	2,218
Total	141	607,680	156	871,886	179	390,406	6	387	482	1,870,359
Totals										
Sailing	81	63,520	19	14,325	....	......	....	....	100	77,845
Steam	240	785,248	283	1,195,912	190	393,393	17	1,858	730	2,376,411
Gas	245	24,975	309	50,048	43	660	70	1,275	667	76,958
Unrigged	211	79,643	68	7,921	27	3,103	31	707	337	91,374
Grand total	777	953,386	679	1,268,206	260	397,156	118	3,840	1,834	2,622,588

* One vessel of 3,427 gross tons built of concrete. † One vessel of 325 gross tons built of concrete. ‡ One vessel of 11 gross tons built of concrete.

MAKES TONNAGE RECORD

American Ship Building Company Has Big Year

The twentieth annual report of the American Ship Building Company, of Cleveland, for the last fiscal year, shows in a concise but illuminating way the enormous amount of work accomplished by the concern and its subsidiaries, the Detroit Ship Building Company, of Detroit; the Chicago Ship Building Company, of Chicago; the Superior Ship Building Company, of Superior, Wis.; the Buffalo Dry Dock Company, and the Milwaukee Dry Dock Company.

The record shows the greatest production of tonnage and largest volume of business of any year since the formation of the company, although with the tonnage two and a half times that of the previous year the earnings were somewhat less.

During the fiscal year, 109 ocean cargo ships, of 422,800 gross tons carrying capacity, were completed and delivered. The company has yet to complete and deliver to the United States Shipping Board Emergency Fleet Corporation sixty-three ocean cargo ships, of 255,900 gross tons carrying capacity. Construction has been delayed by changes ordered by the Fleet Corporation and restrictions imposed limiting the hours of labor. No penalties, however, will accrue through delays in delivery of these ships.

During the year additional plant equipment and other facilities were provided at a cost of $4,018,532.63, in addition to $159,313.80 expended for housing facilities. The company also, during the fiscal year, took $6,150,000 in Liberty Loan bonds, to which the employees added $2,393,500 in subscriptions.

The financial statement shows assets of $152,584,436.89 on a capitalization of $30,000,000, with $15,117,912.41 reserve liabilities, and a surplus of $11,856,987.55.

The officers of the company are: M. E. Farr, president; James E. Davidson, first vice-president; Ora J. Fish, second vice-president and secretary; Alfred G. Smith, third vice-president; W. H. Gerhauser, fourth vice-president; Arthur G. Potter, comptroller; John S. Gorman, treasurer and assistant secretary.

A New Staatendam

The Holland-America Line has begun the building of a new *Staatendam*, which will replace in the Holland-America Line passenger service a vessel of the same name sunk by a German submarine during the war after it had been taken over by the British.

CUNARD LINE PLANS

More Than 500,000 Tons to Be Added To Allied Fleets

While no information regarding their structural features has been received, some details of the shipbuilding programme of the Cunard and allied interests have reached here from their home office in Liverpool, and show that more than 500,000 tons of shipping of the intermediate or passenger and cargo type will be added to their equipment when present plans are carried out.

The *Cameronia,* recently launched, was the first of five vessels of the 14,700-ton type now being built in British yards. At the Fairfield Shipbuilding & Engineering Company's plant, Glasgow, two, which are to be named the *Caledonia* and *Transylvania,* are being constructed for the Anchor Line, while Alex. Stephens & Company, Glasgow, are building the *California* and *Tuscania*. These ships are of the intermediate type, having first class accommodations for 275 passengers, 359 second and 1,184 in third class. They are 550 feet long.

The Anchor Line expects that the *Cameronia* will be available for operation late in the spring. She is to be placed on the run between New York, Londonderry and Glasgow.

Under construction at this time the Cunard and allied lines have a total of 34 ships of 389,000 gross tons. The Cunard has 11 ships of 174,000 gross tons building at the various shipyards in the United Kingdom. Vickers, at Barrow-in-Furness, is building two of these, the *Scythia* and *Aubonia,* and it is expected that they will be delivered late in the spring. None of the vessels under construction is of the size of the *Mauretania* and other super-liners. The first desire of the Cunard Line is to replace the losses of the intermediate types, which carry both passengers and cargo.

Of the allied lines, the Anchor-Donaldson is building at the Fairfield yards two 10,000-ton ships which are to be devoted to the Canadian services. The Anchor-Brocklebank has fourteen vessels, aggregating 105,000 tons, on the ways, while two 10,000-ton ships designed for the Indian services of the Anchor Line are under construction at the Stephens yards.

Contracts have been placed for the building of more than 100,000 additional tons of ships, the keels of which have not been laid.

Liners for West Coast

Seattle, Wash., headquarters of the South American Pacific line, has received unofficial advices that two steel freighters for the West Coast service have been ordered from British builders. One, according to the report, is of 7,000 deadweight tons, and will be built by Robert Thompson & Co., Ltd., of Sunderland, Eng., and the other, of 6,700 tons, will come from the Clyde Ship & Engine Company, of Glasgow.

ORDER GEARED TURBINES

New Steamers Will Be Equipped by Westinghouse Company

The Westinghouse Electric and Manufacturing Company announces that the Merchant Shipbuilding Corporation has awarded to it the contracts for the propelling machinery for two new ships being built at the Company's Chester yards for the Shawmut Steamship Company. These ships, which are designed for general cargo service, will be of about 10,000 dead weight tonnage, and are to have a speed of thirteen knots. Propelling equipment of each will consist of a 4200-shaft-horsepower cross-compound Westinghouse turbines, of the latest type, which will drive the single propeller through double-reduction gears. An oil-relay governor will be provided which will prevent the propeller from racing, even in heavy seas, but will at no time shut the turbines down. As there will be two separate turbines, high and low pressure, and either can be operated independently in an emergency, the danger of crippling the ship by an accident to the machinery is very remote. The gears are to be of the floating-frame type, which automatically keep in alignment in spite of errors or changes in adjustment that would be disastrous to rigid gears.

The main condensing equipment is of Westinghouse make, including the condensers, Leblanc air ejectors and condensate pumps. The system is designed to maintain a vacuum of greater than twenty-eight inches in 70° degrees sea water.

There are now in commission, or being built, over 250 ships equipped with Westinghouse geared turbines.

Five Repair Contracts

Contracts for the repair of five Shipping Board steamers have been distributed among as many yards. Announcement has been made that the *Oscoda* would go to the Vulcan Iron Works, Jersey City; the *Western City* to Tebo's Yacht Basin, Brooklyn; the *Lorain* to Robins Dry Dock & Repair Company, Brooklyn; the *Lake George* to the Marine Iron Works, Brooklyn, and the *Lake Fackler* to the Arthur Tickle Engineering Company, Brooklyn.

Brazil Needs Ships

An American correspondent recently in Rio de Janeiro, Brazil, had an interview with Dr. Cincinnato Braza, Minister of Agriculture, Industry and Commerce, in which the Doctor mentioned many lines in which it would be necessary for Brazil to spend an enormous amount of money in the near future. One part of the interview quoted the Doctor as stating: "During the coming generation we shall need at least 500,000 tons of river and ocean steamships."

TO BUILD 14 SHIPS

National Shipbuilding Company Has Big Job on Hand

Further details of the National Shipbuilding Company's contracts for construction for French interests, mentioned in Ships and Shipping on December 19, have become available, and show that 14 vessels are involved in the contracts, which will be carried out at the Three Rivers, Quebec, yards of the company. It is stated that construction prices are on the basis of $120 per ton, deadweight, for six 7,200-ton boats; $180 for six 4,200-tonners; $185 for one 3,250-tonner, and $185 for one 6,500-ton oil tanker. All the vessels, it is reported, are to be built on the Isherwood system. The dimensions and specifications of the vessels are given as follows:

7,200-ton Steamers—380 feet long, 52 feet beam, 27 feet 4 inches depth, 23 feet 3 inches draft, 2 decks, poop, bridge and forecastle; triple expansion engines, cylinders 26, 43 and 71 inches diameter, 48-inch stroke, 3 boilers, 180 pounds pressure, 15 feet 6 inches by 11 feet 6 inches; trial speed, loaded, 11 knots.

4,200-ton Steamers—310 feet long, 45 feet beam, 22 feet 4½ inches depth, 19 feet draft, single deck, poop, bridge and forecastle; triple expansion engines, cylinders 23, 39 and 64 inches diameter, 42-inch stroke, 3 boilers, 180 pounds pressure, 13 feet by 10 feet 9 inches; trial speed 11 knots.

3,250-ton Steamer—280 feet long, 42 feet beam, 20 feet 9 inches depth, 18 feet draft; single deck; triple expansion engines, cylinders 21, 34 and 57 inches diameter, 39-inch strike, 2 boilers, 180 pounds pressure, 14 feet 6 inches by 11 feet; trial speed, loaded, 10½ knots.

6,500-ton Tanker—380 feet long, 52 feet beam, 28 feet 3 inches depth, 22 feet 9 inches draft, poop, bridge and forecastle; triple expansion engines, located aft, cylinders 27, 44 and 73 inches diameter, 48-inch stroke, 3 boilers, 180 pounds pressure; trial speed 11½ knots.

It is possible that the smallest of these vessels may be built in the Violet, La., yards of the company.

Matson Plans Big Steamer

The Matson Navigation Company of San Francisco has just laid the keels for two 14,000-ton freight carriers. The work will be done at the Moore Shipping Company's plant at Oakland. The boats will be operated between San Francisco and Honolulu. They will be 497 feet overall, 480 feet between perpendiculars, 62 feet beam, 42 feet deep to the shelter deck, and will carry 14,000 tons of sugar.

According to William Roth, vice-president and general manager of the Matson Company, this is only an initial contract. Officials and directors of the company are now working out details of the specifications for a huge steamer, which will be the largest, fastest and most palatial passenger liner on the Pacific. The plans will be submitted to the local builders in the immediate future.

1919'S LAKE SHIPBUILDING

Out of 217 Vessels Not One Was For Local Use

Shipyards on the Great Lakes built 217 vessels during 1919, 188 steamers and 29 tugs, all for the Emergency Fleet Corporation. Although the Lake yards were kept busy the entire season, not a boat was built for the Lakes, all being sent to the coast for salt water service. Fifty-seven steamers and 19 tugs ordered for 1919 delivery were not completed, but most of these will be ready to sail in the spring.

The American Ship Building Company, of Cleveland, built 93 of the steamers completed during the year. The Great Lakes Engineering Works Company, of Detroit, turned out 37, the Toledo Shipbuilding Company built 12, the Saginaw Shipbuilding Company 8, the Manitowoc Shipbuilding Company 12, the McDougall-Duluth Shipbuilding Company, of Duluth, 17, and the Globe Shipbuilding Company, of Duluth, 9 steamers.

The American Ship Building Company now has uncompleted orders for 20 boats. The Great Lakes Engineering Works will build for delivery early next season 7, the Toledo Shipbuilding Company 4, the Manitowoc Shipbuilding Company 7, the Saginaw Shipbuilding Company 6, the McDougall-Duluth Shipbuilding Company 8, and the Globe Shipbuilding Company 5.

Lake shipyards have already received a number of additional orders for boat for salt-water service to be built during 1920.

ADDING TO BIG FLEET

Peninsular and Oriental Company Orders Five Liners

In connection with the recent report of Lord Inchcape, President of the Peninsular and Oriental Steam Navigation Company, it is reported that an order has been placed with Harland & Wolff for five liners of the B class for the Australian emigrant and cargo service, via the Cape. These vessels will be somewhat larger than the previous ships of this class, and will be about 13,800 tons each.

The construction of the first of the ships has been begun at Belfast.

Groton Yard to Continue

P. LeRoy Harwood, receiver of the Groton Iron Works, denies the rumors that the yard is to be discontinued. Following a conference with E. A. Morse, president of the company, a day or two ago, Mr. Harwood announced that there was no truth in the current rumors that the yard was about to close.

"The yard will remain a permanent industry," said Mr. Harwood, "and the year 1920 will not see the dissolution of the plant, as some people have undertaken to state."

BUSINESS NOTES

Westinghouse opportunities for technical graduates are very thoroughly explained in an illustrated pamphlet bearing that title, recently issued by the Westinghouse Electric & Manufacturing Company. In the book is a list of prominent Westinghouse men who entered the company as graduate students, as well as a complete list of schools from which over 5,000 students have entered the employ of the company. Copies of the booklet will be sent to anyone interested, on application to the educational department of the company at East Pittsburgh, Pa.

The Clinton Wright Wire Company, a $16,000,000 corporation of Worcester, Mass., has acquired the Wickwire Steel Company, of Buffalo. The new concern will be known as the Wickwire Spencer Steel Corporation. The principal officers of the corporation will be: President, T. Harry Wickwire, Buffalo; vice-president, Ward A. Wickwire, Buffalo; vice-president and general manager, George M. Thompson, president of the Clinton Wright Wire Company. The headquarters will remain in Worcester.

Under a recent contract received by the Keller Pneumatic Tool Company, of Chicago, for supplying United States Navy yards with all their requirements in pneumatic riveters, chippers, scaling hammers and holders-on for the fiscal year, the first order was for 3,496 tools, divided as follows: Riveters, 881; chippers, 1,428; scalers, 896; holders-on, 291. Additions since the original order was placed bring the present total to approximately 4,000 Keller-Master Tools. With customary "Keller service" promptness, the greater portion of the tools specified were shipped on receipt of confirmation of the order.

Developments of the Ohio Body & Blower Company have made necessary taking over three plants from the older company, the Ohio Blower Company. Plant No. 1 is the three-story plant on Perkins avenue, Cleveland, which served for five years as the home of the company. Plant No. 2 is the new plant housing the home offices, on Detroit avenue, on the West Side of the same city. Plant No. 3 is the modern foundry at Orrville, Ohio, which operates exclusively on the Ohio Blower Company work. These three plants provide employment for more than 600 workers in 150,000 square feet of floor space. Spring will see these figures increased to 1,000 workers and 350,000 square feet of floor space by the completion of another unit of Plant No. 2, to be devoted to the building of closed bodies. The paid-in capital of the Ohio Body and Blower Company affords ample resources for further expansion. The change will not affect the personnel of the management. The officers of the older company, Mr. D. K. Swartwout, president, and Mr. H. H. Lind, vice-president, assume the same offices in the new corporation.

A. H. Dinshaw & Co., of Bombay, B. E. I., importers of machinery, hardware, etc., send word to American manufacturers, through Marine Engineering, that they are interested in woodworking machines, lathes, drilling machines, pumps, oil engines, steam engines, portable steam engines, boilers, grinding mills, oat-crushers, cranes, ice-making plants, hydraulic presses, pumps, air-compressors, etc. Also in mill stores, gin stores, and general engineering sundries.

The New York branch of the American Society of Marine Draftsmen held its annual banquet at the Marlborough Hotel, New York City, on Saturday, January 17, 1920. The principal speakers were: President, Clarence C. Jacobson, of Branch 23; National President A. H. Haag, Mr. J. E. Burke, of Marine Engineering; Mr. Sydney Swan. The subjects discussed were mainly with relation to the importance of the work of the draftsmen during the recently past emergency, and in connection with present and future American merchant marine. New York Branch, No. 23, is now holding regular meetings on the second Thursday of each month at the Engineer Societies building, West Thirty-ninth street, and some very interesting and important papers are being read and discussed. These meetings are of exceptional value to all draftsmen in the locality, and those men not already members of Branch 23 are urged to attend the meetings. A drive for new members is ot be started soon.

The Sizer Forge Company, of Buffalo, announces the opening of a district sales office at 459 Book Building, Detroit, with Mr. L. D. Stanton in charge.

Russel W. Stovel, who has had wide experience with central power station and steam railroad electrification problems, has been appointed as a consulting engineer by Westinghouse, Church, Kerr & Co., Inc., of 37 Wall street, New York.

The Pittsburgh Screw and Bolt Company has opened branch offices at 50 East Forty-second street, New York, in charge of Mr. J. Allen Dillon.

Thomas Christensen and James V. Schraig have organized the East Coast Electrical Supply Company, at 399 Pearl street, corner Vandewater street, New York.

The Black & Decker Manufacturing Company, of Baltimore, has opened an additional office on the Pacific Coast, at 201 Maynard Building, Seattle, Wash. The office is in charge of Mr. A. E. Nordwall, who will have charge of the distribution of Black & Decker products in the State of Washington.

Fairbanks, Morse & Co., of Chicago, will soon start the erection in Beloit, Wis., of the most modern foundry in the world. It will equal in size and output any factory on the globe. This structure will, when completed, be 900 feet long, 550 feet wide, and will contain 495,000 square feet of floor space. The build-

ing, including storage of flasks, iron, sand, etc., which will also be under the roof, will cover eleven acres of ground. It will be directly to the north of the present power house, bordering the River Road. The completed structure will have an ultimate capacity of 300 to 400 tons of gray iron daily, and means the addition of 3,000 men to the working force of the already large plant.

The business of the Carlson-Wenstrom Company and the Carwen Steel Tool Company, Erie avenue and Richmond street, Philadelphia, will be continued by A. H. & F. H. Lippincott, manufacturers of screw machine products who have purchased the assets of these two companies and under their direct supervision will manufacture the Carwen Dynamic Balancing Machine, and all classes of special machinery in conjunction with their screw machine products. Mr. Joseph A. Ganster will be associated with the corporation as director and works manager, and Mr. Jacob Lundgren as engineer. The business will be conducted under the corporate name of Lippincott-Carwen Corporation.

The Diamond Power Specialty Company, Detroit, Mich., announces the appointment of Michael J. Stack as assistant marine manager. Mr. Stack's headquarters will be in the office of the company's marine manager, F. W. Leahy, 32 Broadway, Room 1611, New York City.

The Material Handling Machinery Manufacturers' Association, of which Calvin Tomkins, formerly Dock Commissioner of New York City, is president, has issued a prospectus, entitled "The Right Arm of Industry," which shows the successful record made by the association in its life of less than a year. The office of the association is at 35 West Thirty-ninth street, New York City, and its membership includes nearly every concern of prominence in the country in the line of material-handling machinery.

The Chicago Pneumatic Tool Company announces the appointment of Mr. Edward A. Woodworth and Mr. C. E. Laverenz as special railroad representatives attached to the staff of the Manager of the western railroad sales, with headquarters at Fisher Building, Chicago, Ill.

A contract recently signed between the Fairbanks Company, Broome and Lafayette streets, New York, and the Lincoln Electric Company, of Cleveland, Ohio, gives the Fairbanks Company the exclusive distribution of Lincoln electric motors for industrial applications. This line includes alternating current motors for two-phase and three-phase circuits, in capacities from one-half to 500-horsepower. For all commercial voltages and frequencies, and direct current motors, from one-half to 150-horsepower. The Fairbanks Company will also co-operate with the various Lincoln district offices in connection with the sale of the manufacturer's other products.

Hydraulic Variable Speed Gears

At the recent Shipping, Engineering and Machinery Exhibition held in Olympia appeared the hydraulic variable speed gears produced by the Variable Speed Gears, Ltd., of Westminster.

These gears are for transmitting rotary power at variable speeds in either direction without stops or abrupt graduations, while the source of power rotates in one direction only and at a constant speed.

They consist of an hydraulic pump and an hydraulic motor. The former is driven at a constant speed in one direction and by means of varying the stroke of its pistons the rate of flow of the fluid delivered to the motor can be adjusted from zero to the full capacity of the pump. The motor having a fixed stroke, its speed depends upon the quantity of fluid delivered by the pump. By suitably controlling the stroke of the pump, the motor may be caused to rotate at any speed from that of the pump to zero. Moreover, the stroke-controlling mechanism is further arranged to alter the relative positions of the pistons and consequently to reverse the direction of flow of the fluid, with the result that the motor can be run in the backward position with the same range of speeds as in the forward position.

The pump can also be used alone as a variable delivery pump, in combination with a single-acting or double-acting ram.

Application to Ship Steering Gear

The exhibit at Olympia includes a working model of a ship's steering gear, Fig. 1, as fitted in vessels of the Cunard Line. This installation includes a variable delivery pump, driven by a shunt-wound, non-reversing electric motor, supplying oil to one or other of a pair of rams in accordance with the direction

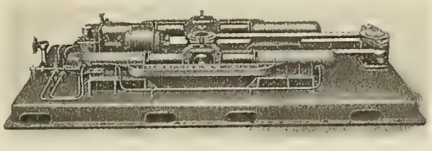


Fig. 1.—Electric Hydraulic Steering Gear Operated by Williams Janney Variable Delivery Pump

in which it is desired to move the rudder. Automatic cut-off gear is provided at the pump for determining the amount of oil to be supplied for any desired position of the rudder. Relief valves are provided on the cylinders so that in the event of the rudder being struck by a heavy sea the oil is by-passed from one cylinder to the other and the stern of the ship relieved of shock. This bypassing of the oil allows the rams to move, and at their movement, by setting in motion the control gear on the pump, puts sufficient stroke on the pistons to restore the rudder automatically to its former position.

The control of the gear is by means of an hydraulic telemotor from the bridge, and a mechanical steering pedestal is provided on the poop deck for use when steering from the aft position.

For operating the rudder by hand two teak wheels are provided, and these operate a quadrant forming part of the tiller, through worm and spur gearing, which gives the necessary reduction between the steering wheels and the rudder post.

The entire absence of mechanical gearing between the electric motor and rudder post, together with the direct connection between the rams and tiller, makes this type of steering gear quite noiseless.

Yard Capstan

A standard type of yard capstan, as shown in Fig. 2, was also exhibited. In this an electric motor is used for driving the capstan spindle through a totally

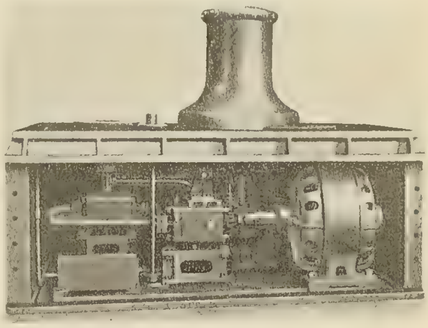


Fig. 2.—Standard Yard Capstan with Variable Speed Gear Installed

inclosed worm gear. By reason of the high starting torque obtainable, coupled with an infinitely slow speed on the capstan, a steady pull equal to three times the normal load can be obtained on the rope, while any speed from zero up to the maximum speed of the capstan can be got without stops or abrupt graduations. The provision of relief valves in the variable speed gear itself protects the rope from breakage.

McMILLAN'S NEW VESSEL

Arctic Explorer Will Start North In July Next Year

Donald B. McMillan, the Arctic explorer, has contracted with Hodgdon Brothers, of East Boothbay, Me., for an auxiliary knockabout schooner of 55 gross tons. The craft will be named *Bowdoin*, for Bowdoin College. Her principal dimensions will be 85 feet long over all, 22 feet beam and 9 feet 7 inches draft. A 45-horsepower Fairbanks-Morse kerosene oil engine will furnish auxiliary power. The cruising radius will be 3,000 miles and tank capacity 2,000 gallons.

The *Bowdoin* is designed especially for Arctic exploration. Her owner intends to start North in July, 1921, on a two-years' voyage. He was with Peary when the latter reached the North Pole in 1909.

SCHWAB FAVORS SUBSIDY

Says Workmen Should Have Representatives in Business

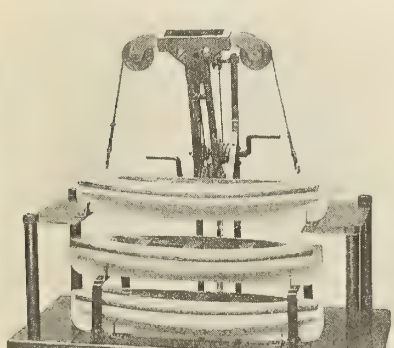
Charles M. Schwab, President of the Bethlehem Steel Corporation, at a recent dinner of the Rubber Association, said that the American merchant marine cannot be developed unless shipping laws are revised to allow private capital a profit. He intimated that subsidy for American ships would be desirable, adding that before business can be re-established on a firm basis the present period of extravagance must be curbed. He added that most of the cost of manufactured articles was for labor, and regarded as the principal industrial problem management, disposition and encouragement of labor.

"Treat labor well," he urged, "make your workmen partners; allow them to have representatives in the conduct of business, and do not permit agitators to tell you what to do. Then establish your business on a solid basis."

New T-Head Boat Davit

A new boat davit has recently been invented by G. Torrie, of London, The object of this invention is to provide means for lowering and raising ships' boats by means of a single davit placed on a platform on the inboard-side above and projecting over the boats.

The davit is supported at about 3 feet from the bottom end and can be swung inboard and outboard as desired by means of worm gear fixed at the bottom end of the davit, or by ropes led to winding gear. There are two single falls, which engage the hooks in the



New "T" Head Boat Davit

boats at points about 9 feet from the bow and stern. The falls are led up at a slope of about 3 feet out of the perpendicular, around swiveling wheels coupled together by means of a hollow shaft, through which the falls pass down to the winch gear, fixed on the davit or deck. Hydraulic, steam, electric or hand power may be used to operate the hoists, as desired.

A seven-foot "T" head davit would probably be found suitable for a 24- or 28-foot boat, but this length might be altered for different types of life boats.

It is claimed by the inventor that the davit has the following advantages:

Owing to the use of two single falls, there can be no danger of the falls getting entangled. The boat can be lowered on an even keel without danger of tipping up. It is not necessary to swing the boat over the ship's side before loading, but while the boat is at rest on the deck the passengers can take their places with greater safety and a considerable saving of time in launching.

In the event of the ship having a heavy list, the boats can still be lowered from the high side. The boats could be filled up and lowered faster, and not so many men required for launching purposes per boat. The davit can be adapted to one boat or any number up to five boats per station. Owing to the construction of the "T" head, no guy ropes are required for keeping the boat parallel with the ship's side

American-Made Tracing Cloth

The National Tracing Cloth Company of Saylesville, R. I., after a great many years' experience in the manufacture of cloth, has produced the first, and, so far, the only American-made tracing cloth. For nine years special research work has been carried on to bring the manufactured product of this country up to the required standard.

The yarn from which the cloth is made is selected from long staple cotton, especially carded and combed to eliminate all foreign particles that would be detrimental to the clearness of the finished article, as well as to secure the high tensile strength necessary to the best grades of tracing cloth.

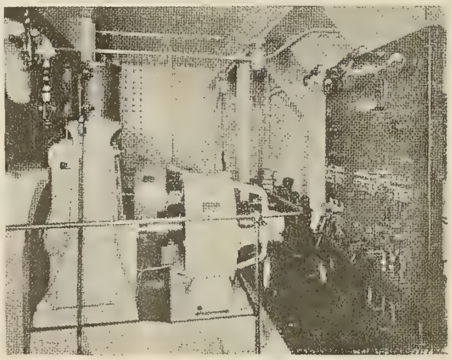
Samples of this cloth, backed by the strongest possible guarantee, will be supplied to anyone who may wish to personally test it under working conditions in his own office.

New Marine Lighting Outfit

A new line of engine-driven marine lighting generators, designed especially to insure reliability of operation, has recently been developed by the Westinghouse Electric and Manufacturing Company. The sets range in size from 2 to 50 kilowatts, and each consists of a steam engine coupled to a generator, the whole being mounted on a bed-plate so as to form a compact unit. The 15 kilowatt size, shown in the illustration, is six feet long, three feet wide, five feet high and weighs about 3,300 pounds.

The engine used in these sets is manufactured by the Clarage Fan Company. It is of the single-cylinder, vertically enclosed V-type with automatic lubrication. It can be supplied for operation on steam pressures of from 80 to 250 pounds, and is suitable for either condensing or non-condensing service. The engine speed ranges from 500 revolutions per minute in the smallest sizes to 350 revolutions per minute in the largest.

The generator, while in general of standard Westinghouse construction, is especially designed for marine service. The bearings are arranged so that proper lubrication is assured regardless of the tossing of the vessel. The windings are especially insulated to protect them from salt and dampness. Metal



Two 15-Kilowatt Westinghouse Generators on S. S. *Britto*

parts subject to corrosion are made of non-corroding alloys. A special feature of these generators is their freedom from sparking at the commutator, even under heavy overloads. They are supplied for either 125 or 250 volts, direct current, and for either two- or three-wire systems.

PERSONALS

A. G. Gibbons, formerly superintendent of the department of tools and supplies, Winslow Brothers Company, Chicago, has now become affiliated with the Wetmore Reamer Comapny, 210 Sycamore street, Milwaukee, Wis., as production engineer.

A. H. Ashford has opened a sales office and warehouse for the Western Electric Company at 334 East Bay street, Jacksonville, Fla. F. H. Van Gorder has been appointed manager of the Newark store of the company.

The Ingersoll-Rand Company has established a new office in the Sam Houston Life Building, Dallas, Tex., under the management of R. H. Brown, Jr.

Charles Cory & Son, Inc., with main office and factory at 290 Hudson street, New York, has opened branch offices at 207 Market street, Philadelphia, and at 83 Columbia street, Seattle, Wash.

The Lidgerwood Manufacturing Company, New York, has opened a branch office under the management of R. S. Hutchinson in the Hammond Building, Detroit, Mich.

A. C. Hidalgo has been made special South American representative of the Worthington Manufacturing Corporation, a subsidiary of the American Steel Export Company. J. C. Devereaux, chief city salesman of the American Steel Export Company, has taken over the sales for the Worthington Manufacturing Corporation in this district.

RECLAIMING RIVETS

Two Machines of Value to Shipyards

One problem encountered by the salvage department of shipyards has been the reclamation of rivets, bolts and nuts which have accumulated rapidly and in many cases have been scrapped because of the expense of making them fit for use again. Many devices have been developed in various yards to reduce this salvage expense, and two types of machines produced by the International Reclaiming Company, installed in the shops of the New York Shipbuilding Corporation, Camden, N. J., are particularly interesting. The machines have been placed on the market by Nelson, Lodge & Snyder, Widener Building, Philadelphia, Penn.

One machine, consisting of a worm and double-gear, motor-driven table, as shown in Fig. 1, is used for sorting rivets and bolts according to length. The table is made up of cast iron segments slotted on the outer edge for carrying rivets or bolts. Two full sets of segments, one for handling ⅝-inch and ¾-inch diameter material, and and the other ⅞-inch and 1-inch diameter, are supplied with the machine. Segments may, however, be used to accommodate any diameter of bolt or rivet. Material to be sorted of a single diameter, but of any length, is fed to the tray immediately above the machinei and inclined towards the operator, who places the pieces, as they move down a slide, into slots of the revolving table, which turns at about three revolutions per minute. This particular table speed has been determined as best for allowing the operators, working normally, to fill all the slots as they pass. As each rivet or bolt comes in contact with a cam set for its particular length, it is dropped through a chute to a keg containing bolts of that length. There are twenty cams arranged on the machine which may be adjusted to sort the bolts within ⅛-inch of any required length.

Fig. 1.—Rivet and Bolt Sorting Machine

The relative costs of sorting by the hand-method and by machine indicate a saving per ton of about $6.34, according to the following schedules:

COST BY HAND

Two experienced men measuring bolts or rivets by hand can sort about twelve kegs in a 12-hour day.

Labor: Two men at 54 cents per hour...	$8.64
Normal Output: Twelve kegs, or 1 1/5 tons.	
Sorting Cost Per Ton:	$7.20

COST BY MACHINE

Two ordinary men working normally can feed rives or bolts to a sorting machine at the rate of 125 per minute, or 7,500 per hour. Assuming three pieces to the pound, this means 100 kegs per day.

Labor: Two men at 54 cents per hour...	$8.64
Sorting Cost Per Ton:	$0.86

Machine for Assembling Nuts and Bolts

Another machine of particular value in the salvage department is one developed for bolt and nut assembling. It it intended to replace the rather expensive bolt-threading and bolt-tapping machines ordinarily used. Bolts and nuts that have corroded form the great bulk of this type of material to be reclaimed in the shipyards. The machine is driven from a countershaft by open and crossed belts engaged by a foot-operated clutch on both the forward and reverse motions. The operation on the bolt is quite simple, consisting of clamping the bolt in a chuck, while a sliding chuck holding the nut runs it up over the threads.

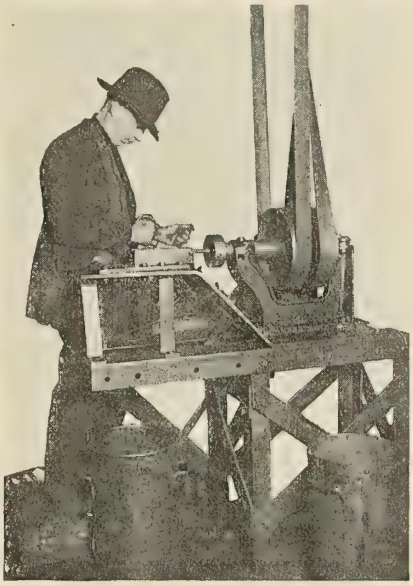


Fig. 2.—Bolt and Nut Assembling Machine

For the purpose of comparing the costs of operation, the following data have been arranged from the performances of one bolt and nut assembling machine, and one triple-head, bolt-threading machine in conjunction with a six-spindle bolt-tapping device.

Production is on the basis of 3,000 pieces a day. The normal output for each method is as follows:

USUAL METHOD

Interest on investment, 6 percent......	$1.00
Depreciation and maintenance, 15 percent	2.50
Insurance, ¾ percent	.15
Labor threading, at 62 cents............	4.96
Die replacement (1½ sets)............	9.00
Power, 10-horsepower 60 kilowatt hours, at 2 cents	1.20
Labor tapping, at 62 cents............	4.96
Tap replacement (3)	5.25
Total per day	$29.02
Total per 1,000	9.67

BOLT AND NUT ASSEMBLING MACHINE

Interst on investment, 6 percent............	.19
Depreciation and maintenance, 15 percent	.48
Insurance, ¾ percent	.03
Labor starting nuts, at 46 cents............	3.68
Labor operating machines, at 52 cents....	4.25
Power, 1½-horsepower 9 kilowatt hours, at 2 cents	.18
Total per day	$8.81
Total per 1,000	2.94

The Yale & Towne Manufacturing Company, of 9 East Fortieth street, New York City, announce the removal of their New York offices to Stamford, Conn.

The appointment of J. G. Miles to the position of supply division manager of the Westinghouse Electric and Manufacturing Company's Seattle office became effective January 1, 1920. Mr. Miles succeeds Mr. C. V. Aspinwall, now the company's representative at Spokane, Wash.

The Irving Iron Works Company, Long Island City, N. Y., has been awarded the contract for supplying all flooring-grating, walkways, and ladder steps for the two new super-dreadnaughts *California* and *Tennessee*. The product furnished will be standard Irving "Subway" grating and Irving "Safesteps," such as is already in use on over 500 vessels, including ships if the U. S. Army and Navy, the Emergency Fleet Corporation, and private concerns. The grating is to be galvanized throughout—a refinement in line with the exceptional requirements on these two new fighting vessels.

A statement of the results of a conference on the standardization of export quotations and American export practice, participated in by the nine great foreign trade organizations of the United States, and held under the auspices of the National Foreign Trade Council, has been issued by the council. Copies may be obtained by addressing O. K. Davis, secretary of the council, 1 Hanover Square, New York City.

The Black & Decker Manufacturing Company, of Baltimore, Md., will display their exhibit of electric air compressors, portable electric drills and electric valve grinders in Space E-88-89 at the coming Minneapolis Automobile Show. R. G. Ames, Chicago manager for the company, will be in charge.

Members of the engineering profession are invited to give thought to the opportunity to acquire foreign trade information offered by the Seventh National Foreign Trade Convention, which will be held in San Francisco, May 12-15, 1920. Announcement is made that at the coming Convention special trade advisors will be present from the Far East, Australasia and South America, to be consulted by American business men. In conjunction with the Convention there will be special foreign trade exhibits, held under the auspices of the Los Angeles and Seattle Chambers of Commerce in these two Coast cities.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIP CONTRACTS

Schooners, Victoria, B. C.—Six 2,000-ton five-masted topsail schooners are planned to be built by a new company, headed by Mr. Harry Barnett.

Repairs to Steamers, Baltimore, Md.—Baltimore Dry Dock & Shipbuilding Company has received two new repair contracts—the steamers Saris and Angelina.

Lighthouse Tenders, Morris Heights, N. Y.—The Consolidated Shipbuilding Corporation has been awarded contracts by the Department of Commerce for the construction of two lighthouse tenders at a cost of $714,000.

Converting Barge, Noank, Conn.—The Groton Iron Works are converting the excursion barge Empire into a cargo carrier. She is owned by the Thames Specialties Company of Montville.

Skinner & Eddy Corporation, Seattle, Wash.—It is understood that the Skinner & Eddy Company has several large private contracts pending, on which work will begin early in the year.

Harbor Tugs, Eastport, Md.—Three 100-foot harbor tugs are under construction for the Shipping Board at the Chance Marine Construction Company's yard, at Eastport, near Annapolis, Md.

Dredge Hull, Portland, Ore.—The United States Engineers' Office has let contract for building one wooden dredge hull, with house, First District, to Skandia Shipbuilding Company, Marshfield, Ore. Cost $12,883.

Freight Steamers, Baltimore, Md.—The Baltimore Dry Docks & Shipbuilding Company will build two freight steamers on own acount. They will be 353 feet long, 49 feet beam and 28 feet 7 inches in depth.

The Lake Union Dry Dock & Machine Works, Lake Union, Wash., has sixteen cannery tenders and fishing vessels assembled at its new plant with a large number of smaller craft to be repaired and overhauled.

Sailing Vessels, Eureka, Calif.—The Rolph Shipbuilding Company will lay the keel for a five-masted barkentine with a lumber capacity of 2,000,000 feet, and which will be the largest sailing vessel ever launched on the Pacific coast.

A Submarine Tender and Repair Ship at Bremerton, Wash., at an estimated cost of $6,250,000, have been authorized for construction at the Puget Sound Navy Yard. The vessels will be built in the large dry dock recently dedicated.

Repairing Steamer, Staten Island, N. Y.—The National Dry Dock & Repair Company has been awarded the contract to repair the steamer Neuse, at a cost of $89,000. The work will require fifty-six days and the boilers will have to be rebuilt.

Oil Tankers, San Francisco, Calif.—The Schaw-Batcher Shipyards, South San Francisco, have received a contract from the Union Oil Company for the construction of two 12,000-ton tankers which it is estimated will carry about 87,000 barrels of oil.

Repairing Steamer, Tacoma, Wash.—The Todd Dry Dock & Construction Corporation, Inc., Tacoma, has been awarded a contract by the Shipping Board for repairing and overhauling the steamship Eastern Guide, to cost approximately $100,000. The ship is to be converted from a coal to an oil burner.

Liners for Peninsular & Oriental Steam Navigation Company.—It is reported that an order has been placed with Harland & Wolff, Belfast, for five liners of the B class for the Australian emigrant and cargo service, via the Cape. The ships will be about 13,800 tons each.

Freighter and Tanker, Freeport, Tex.—The Freeport Sulphur Company is having two new 6,000-ton vessels built in a New Jersey shipyard. One of these vessels is a tanker, the other is a freighter which is being built especially for the transportation of sulphur. Both vessels wil draw 22 feet of water.

Fourteen Isherwood Type Ships, Three Rivers, Que.—The National Shipbuilding Company has been awarded contracts by French interests for building six 7,200-ton boats on a basis of $120 per ton, six 4,200-tonners at $180 per ton, one 3,250-tonner at $185 per ton, and one 6,500-ton oil tanker at $185 per ton.

Ocean Vessels, Great Lakes.—The American Shipbuilding Company, Cleveland, Ohio, is obtaining material for several vessels to be delivered at tidewater in 1920. The McDougall-Duluth Shipbuilding Company, Duluth, Minn., and the Manitowoc Shipbuilding Company, Manitowoc, Wis., are to build four steamers for ocean trade.

Refitting Steamers, Chelsea, Mass.—The Richard T. Green Company has finished extensive repairs and refitting contracts on the steamers Hahoning, Waxahachie, Lake Medford, Alvada, Lake Faulk, Lake Fonda, Lake Ellenorah, Lake Fannin, and Lake Fithian for the United States Shipping Board.

Merchant Fleet, Argentine, S. A.—The Argentine Government is planning to create a merchant marine of about 400,000 tons, in order to be independent of foreign shipping. This merchant fleet, consisting of vessels of large tonnage, will be built in Spanish shipyards, with part of the proceeds of the $100,000,000 loan now being negotiated by the Argentine Government with the Bank of Spain.

Reconditioning Steamer, Belfast, Ire.—The United Fruit Company's steamer Sixaola (5,000 tons), has been placed in the hands of Workman, Clark & Company for reconditioning on release from four years' Government service. The Sixaola is the fifth vessel of the "White Fleet" now in the port for a similar purpose, while several others are on the stocks. The Sixaola will be converted into an oil burner.

Steel Cargo Vessels, Finland.—Maskin-och-Brobyggnads Aktiebolaget has launched the Finlandia, owned by the Atlantic Rederiaktiebolaget. This is the first of a number of vessels contracted for, and represents the successful culmination of an attempt to build steel cargo vesels in Finland. The Finlandia has 1,500 deadweight tons capacity, built at a cost of 3,000 Finnish marks per ton. (The present average exchange value of the Finnish mark is 5.75 cents.)

Tanker, Tampa, Fla.—The Oscar Daniels Company received a contract from the Standard Oil Company of New Jersey for constructing a tank oil carrier of 11,000 tons. The vessel will be 481 feet long over all, 465 feet between perpendiculars, 60 feet beam, and 36 feet 3 inches deep from shelter deck. The engines will be oil-burning quadruple expansion, of 2,800 horsepower, with three Scotch boilers, and will give a speed of ten and a half knots. The contract calls for completion this year.

Steamships, Cunard and Allied Lines, Glasgow.—The Cunard and allied interests have thirty-four ships under construction at the yards of the Fairfield Shipbuilding & Engineering Company and Alex, Stephens & Company in Glasgow, and the Vickers Yard at Barrow-in-Furness. They are all of the intermediate, or pasenger and cargo carrying type. Contracts have also been placed for more than 100,000 additional tons, the keels of which have not yet been laid. The aggregate tonnage when the program is completed will be more than 500,000 deadweight tons.

Auxiliary Knockabout Schooner, East Boothbay, Me.—Hodgdon Brothers received a contract from Donald B. McMillan, the Arctic explorer, to build an auxiliary knockabout schooner of 55 gross tons. The craft will be named Bowdoin, for Bowdoin College. Her principal dimensions will be 85 feet long over all, 22 feet beam and 9 feet, 7 inches draft. A 45-horsepower Fairbanks-Morse kerosene oil engine will furnish auxiliary power. The cruising radius will be 3,000 miles and tank capacity 2,000 gallons. The Bowdoin is designed especially for Arctic exploration.

Tankers for Sinclair Navigation Company—Contracts have just been placed by the Sinclair Navigation Company, 120 Broadway, this city, for eight bulk oil carriers, aggregating more than 77,000 dead weight tons. Four of the ships, two of 10,600 tons each and two of 6,900 tons each, are to be built by the Harlam plant of the Bethlehem Shipbuilding Corporation, Ltd., at Wilmington, Del.; two of 10,600 tons each by the same corporation's plant at Fore River, Quincy, Mass., and two of 10,600 tons each by the Sun Shipbuilding Company at its Chester, Penn., plant.

NEW SHIPYARDS AND SHIPYARD EXTENSIONS

Canada to Aid Shipyards.—The Canadian Government has decided to make loans to all Pacific coast yards needing assistance, up to 75 percent of the cost per ship, according to advices received at Seattle.

Floating Dry Dock, Vancouver, Wash.—The Port Commission and other interests of the city are considering the building of a floating drydock of six wooden pontoons, with steel wings, for ships of 12,500 tons capacity.

New Shipyard, Halifax, N. S.—C. N. Delaite of the Winnisimnet Shipyards, Chelsea, Mass., was recently in Halifax looking over its possibilities as a site for a branch yard. The plant, if built, will construct wooden ships of all classes.

Lining Dry Docks, Paris Island, S. C.—Spec. 3979—Until February 4 bids will be

received by the Bureau of Yards and Docks, Navy Department, Washington, D. C., for lining dry dock with concrete. $10 deposits required for plans and specifications.

Boat Building Yard, Karachi, India.—B. R. Herman & Company are about to erect a plant for the building of boats, motor boats, launches, etc. The new plant will be on a water frontage, and will have all equipment necessary to the economical and expeditious conduct of industry.

Floating Docks, Argentina, S. A.—A proposed series of floating drydocks to cost not less than $20,000,000 has been suggested to the Congress of Argentina. Plans call for the construction of 18 of these structures, to be located in the Parana, Uruguay and Paraguay rivers.

Groton Iron Works, Noank, Conn.—P. LeRoy Harwood, receiver of the Groton Iron Works, denies rumors that the yard is to be discontinued. "The yard will remain a permanent industry," said Mr. Harwood, "and the year 1920 will not see the dissolution of the plant."

Shipyards Sold, Portland, Ore.—Messrs. Barde & Son have bought the Sommarstrom Shipbuilding Corporation's yard equipment and have started wrecking operations. The company also took over the Foundation Company's equipment, and that of the Albina Engine & Machine Works.

Dry Dock, Portland, Ore.—The city is having plans prepared by G. B. Hegart, chief engineer Public Dock Commission, for a 15,000-ton drydock, consisting of five pontoons, 3,000 tons capacity each, similar to the large docks of the Skinner & Eddy Shipbuilding Company, to cost about $800,000.

Repairing Dry Dock, Brooklyn, N. Y.—Spec. 4014—Bids will be received until February 11, by the Bureau of Yards and Docks, Navy Department, Washington, D. C., for repairing drydock No. 4, in the Navy Yard, Brooklyn. About $100,000; $10 deposit required for plans and specifications.

Shipyard Control Changed, Wilmington, Del.—The yacht and boat building business of Beebe & Baxter has been taken over by William H. Beebe and Captain Malcolm Billsborough, who plan a number of improvements. The firm is at present engaged in finishing the yacht Pythagoras, for E. Paul du Pont.

Wood Cutting Shop, Lake Union, Wash.—The Lake Union Dry Dock & Machine Works is about to begin construction of large wood cutting shop, the machinery and lumber for which has already been assembled. In conjunction with the Lake Union concern, Estep & Kimball will establish a $75,000 machine shop in one of the plant buildings.

Dry Dock, Quincy, Mass.—Preliminary work on the big dry dock to be built for the Bethlehem Shipbuilding Corporation has begun. In connection with this a contract for $500,000 was recently let to M. M. Davis & Son, Inc., for the construction of ten pontoons, each to be 116 feet long, 41 feet wide, and 13½ feet deep. The dry dock will accommodate ships of 10,000 tons.

Shipyard Leased, Houghton, Wash.—Preparatory to entering the ship repair business on a large scale and to complete two wooden ships now on the ways, the J. H. Price Construction Company has taken over the Adverson Shipbuilding Corporation's plant at Houghton, Lake Washington, under a five-year lease. Six small vessels are at the plant for repairs, and others are ready for overhauling.

The Lord Dry Dock Company, a subsidiary of the Lord Construction Company of Providence, R. I., has taken over the plant of the Weehawken Dry Docks Company and purchased 2,000 front feet of land on the west shore of the Hudson river and will carry on extensive ship repair work. Six piers, 1,000 by 60 feet, are called for by present plans. Each pier will carry two tracks on a concrete dock. Shops will be of concrete and steel, the buildings 250 by 125 feet, and two 10,000-ton floating docks, one to become part of the equipment as soon as possible, are to be built.

New Shipbuilding & Dry Dock Company, Baltimore, Md.—The Globe Shipbuilding & Dry Dock of Maryland, an extension of a company of the same name located at Superior, Wis., of which Benjamin C. Cooke is president, has purchased a thirty-acre tract with 1,000 feet water frontage in the Curtis Bay section of Baltimore, will move the Superior plant to Baltimore bodily, and create a large shipbuilding and repair plant. The project is backed by Baltimore business men and bankers, and the work is to be completed within the next ninety days.

Dry Dock, Pensacola, Fla.—The Bruce Dry Dock Company has launched the second section of its 6,000-ton drydock. The third and fourth sections are well under way, and it is expected that the dock will be ready for commissioning by April 1. The second section was 65 feet in length, 94 feet in width, and had a pontoon twelve feet deep. There will be five sections in all. The company has awarded contracts for three fireproof buildings to be used in connection with the dock's operation. One of these will be 100 by 80 feet, one 86 by 40 feet, and the third 100 by 160 feet.

HARBOR IMPROVEMENTS

Jetties, Humboldt Bay, Wash.—The United States Engineers Office, War Department, Washington, has rejected bids for furnishing stone for jetties.

Dredging, Savannah, Ga.—The U. S Engineer office has let contracts for dredging in Savannah Harbor to J. Emile, Duval Building, Jacksonville, Fla. About $94,500.

Dredging, Nantucket Sound.—The United States Engineers Department announces the establishment of special buoys in Nantucket Sound to facilitate dredging operations.

Dry Dock, Astoria, Ore.—The Port of Astoria Commission is having plans prepared for a drydock, to cost about $1,000,000. R. R. Bartlett, Astoria, engineer in charge.

Dredging Canal, Beaumont, Texas.—The Lake Arthur Dredging Company made the lowest bid of $135,000 for dredging a canal between Mermentau and Calcasieu Rivers.

Quarantine Station, Providence, R. I.—Strenuous and persistent efforts are being made to secure the construction of an adequate quarantine station, to cost about $600,000.

Repairing Coal Wharf, San Diego, Calif.—Spec. 4117.—The Bureau of Yards and Docks, Navy Department, Washington; plans to repair coaling wharf here. About $4,000.

Harbor Improvements, Antofagasta, Chile.—The Chilean Government has contracted for harbor improvements to be made at Antofagasta, costing approximately $8,500,000.

Extend Harbor Area, San Francisco, Calif.—City plans to extend harbor area by removing Rincon Hill, involving 3,000,000 cubic yards earth excavation. Cost will be about $3,500,000.

Dock, Portland, Ore.—The Crown Mills has let contract for building a dock 100 by 106 feet, on Front street between Ninth and Tenth streets, to A. Kaufman, Gasco building. Cost about $30,000.

Dredging, Seattle, Wash.—U. S. Engineer Office, War Department, Washington, D. C., plans to dredge the channel at entrance to Port Gamble Harbor, 2,500 feet long, 28 feet deep and 150 feet wide. About $24,000.

Municipal Wharf, Etc., Orange, Tex.—The $150,000 issue of wharf and dock bonds has been disposed of, and work can now be pushed on the municipal wharf and dock improvements to be made wtih the money.

Buoys, Yorktown, Va.—Spec. 4068.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., has let contract for furnishing four mooring buoys here to S. J. Smith, Gloucester Point, $6,576. (120 days.)

Dredging, Stamford, Conn.—Proposals for dredging in Stamford Harbor, Conn., will be received at the U. S. Engineer Office, Providence, R. I., until 2 o'clock P. M., February 9, 1920. Further information on application.

Floating Terminal, St. Louis, Mo.—The United States Railroad Administration has let the contract for building a floating terminal 280 feet long and 75 feet wide to the Dubuque Iron Works, Dubuque, Ia. Cost $280,000.

Pier, Portland, Me.—The Maine State Pier Commission, offices in Augusta, Me., plans to build a concrete and steel pier at Portland to cost about $2,000,000. Fay, Spoffard & Thorndike, 15 Beacon street, Boston, are the engineers.

Dredging, Wilmington, Del.—U. S. Engineer Office, Old Federal Building, has let contract for dredging in Cooper River to American Dredging Company, Mariners & Merchants' Building, Philadelphia, Penn. About $9,500.

Quay Wall, Norfolk, Va.—Bureau of Yards and Docks, Navy Department, Washington has let the contract for building a quay wall at Norfolk, to H. P. Converse, Thirty-first street and Colonial avenue. About $250,634; time limit 300 days.

New Harbor, Nairn, Scotland.—The Town Council of Nairn is planning to extend and improve the harbor there, with a drift shelter to accommodate about fifty steam or motor fishing vessels. The total cost is estimated from £95,000 to £100,000.

Dredging, Delaware River.—Bids will be received by the United States Engineers Office, 815 Witherspoon building, Philadelphia, until February 18, for dredging Delaware River, Philadelphia Harbor. Information at above address.

Pier, Curtis Bay, Md.—Standard Guano Works, 1214 Continental Building, Baltimore, have let contract for building 40x200 ft. wood pile and timber pier at plant there, to Whiting-Turner Company, Stewart Building, Baltimore, Md. About $50,000.

Dredging, Astoria, Ore.—The Port of Astoria Commission has preliminary plans for dredging Youngs Bay, Port Dock to Wilsons, cost $15,000. Port Docks piers 4, 5, 6, $200,000; Wilsons to Wallusky, $385,000. R. R. Bartlett, Astoria, is engineer.

Harbor Improvements, San Francisco, Calif.—The Board of Harbor Commissioners has completed plans for the construction of $2,000,000 worth of harbor improvements which wil greatly increase the present wharf facilities and relieve the seasonal freight congestion.

Coal Dock and Loading Pockets, Grand Rapids, Mich.—Kent Fuel Company, 1230 Taylor avenue, have let contract for building reinforced concrete coal dock and loading pockets, including conveyor and electrically operated loading machine, to A. W. Morgan, Grand Rapids.

Shipping Terminal, Seattle, Wash.—The new public shipping terminal now in process of construction at Smith Cove, at a cost of $2,500,000, will be ready to berth ships and handle cargo by May 1, according to George F. Nicholson, chief engineer of the Seattle Port Commission.

Dredging, Mystic River, Conn.—The State Department of Public Works through the Department of Waterways and Public Lands has undertaken the dredging of the entrance to the Mystic River. The plan calls for a depth of 30 feet at mean low water near the mouth of Island End River.

Shed and Piers, New York.—Department of Docks Pier "A" North River, has let a contract for building a shed at Eighteenth Street Pier, East River, and reconstructing pier at foot of Twenty-fifth street, East River, to the Associated Contractors, Inc., 17 West Forty-second street, New York.

Industrial Plants, Baltimore, Md.—The Union Acid Works will build a $1,000,000 plant and will dredge a 25-foot channel and build a modern pier with a 2,000-ton capacity. The Kennedy Corporation will build a $2,000,000 plant for the manufacture of automobile parts, with shipping connections.

Wharf and Warehouses, Charleston, S. C.—The wharf and warehouses of the Accommodation Wharf & Warehouse Company were sold to Henry F. Barkerding, Charles R. Allen, Hyman Pearlstine and E. F. A. Wieters for $200,000, who intend to make extensive improvements on the property.

Equipment of Docks, Leith, Scotland.—The Dock Commissioners of Leith have decided to spend £52,000 for the purpose of further equipping docks with capstans to be placed at suitable points so as to permit hauling of wagons along quay fronts, where locomotive haulage is unsuitable and uneconomical.

Improvements on River Front, Sacramento, Calif.—John Q. Brown, Commissioner of Public Works, announces that immediate action will be taken to better conditions on the waterfront, and has instructed City Engineer Frank C. Miler to make a survey in order to determine an estimate on the probable cost of contemplated improvements.

Pier, Fore River, Mass.—It is expected that in the early spring a new wharf, warehouses and apparatus for loading and unloading ships and railroad cars will be erected on the 310,000 feet of land recently purchased by John W. Gulliver, of Portland, acting for Philadelphia interests. This involves an expenditure of about $550,000.

Widening Channel, Willapa Harbor, Wash.—The United States Dredging Company was the only bidder for the widening of the main channel of Willapa harbor to a width of 200 feet. The bids were asked for by the United States Engineers Department. The bid submitted calls for $14.95 per cubic yard for removal of rock from the channel, and $0.1795 for dirt.

Pier, Colon, Panama.—The deck construction department of the Panama Canal is building a pier on the foundations of the old pier of the Royal Mail Steamship Company. The new pier is 490 feet long, 62 feet wide. The floor is of reinforced concrete, the roof supported by 20 trusses, and both it and the side walls will be of corrugated iron. A track of the Panama Railroad wil run to the pier.

Wharf, Etc., Everett, Wash.—The Port Commission proposes to buy 1,700 acres of tide flats for development as future wharf and industrial sites. These flats lie to the left of the Snohomish River, where it enters the Sound at the north end of the peninsula on which Everett stands. Construction of retaining walls, and extensive dredging and filling, will be necessary to make the tract available for use.

Sea Wall, Etc., Toronto, Ont.—The city plans to build a precast mass concrete sea wall on wood piles from Humber River to Eastern Gap, a brick and steel warehouse at the foot of York street, large bathhouse, wood construction, amusement park at Sunnyside, improve beach at Scarboro, and complete Sunnyside boluevard. About $4,000,000. E. L. Cousins, Harbor Building, engineer.

Reconstruction, Delaware and Chesapeake Canal.—It is announced that the Federal Government plans to spend $2,000,000 on improvements and reconstruction work on the Delaware and Chesapeake Canal before June, 1921. The work includes purchase of land, construction of new bridges, dredging and other contract work. Information can be obtained from Col. John P. Jervey, U. S. Engineers Office, Wilmington, Del.

Harbor Improvement, Warrenton, Ore.—The Port of Warrenton has empowered a dock commission and authorized the issuing of $350,000 in municipal bonds to carry on work of improving its waterfront. A second measure authorizing $150,000 in bonds for the purchase of two tracts of water frontage of fifty acres each, on the Skipanon and Columbia Rivers, to be fitted up for warehouses, dockage and industrial purposes, has also been adopted.

Tanks, Seattle, Wash.—The Seattle Boiler Works has won the contract on its bid of $13,980, from the Port of Seattle Commission, for the construction of two 250,000-gallon steel oil tanks at the Pier A terminals at Smith Cove. The tanks are already leased, as are two other 50,000 gallon tanks now being completed by an Oriental oil company entering the field, the identity of which has not yet been announced. The tanks will be completed in sixty days.

Dredging Channel, Duluth, Minn.—Plans for dredging the channel of sufficient depth to enable the largest Great Lakes freighters to approach the new receiving dock of the Zenith Furnace Company of Duluth are completed. The improvement, which will involve an expenditure of about $10,000,000, calls for deepening the St. Louis River a distance of nearly a mile through Spirit Lake. The dock will be large enough to handle four boats at one time with modern unloading bridges and equipment.

Dredging and Slips, Tacoma, Wash.—The Port Commission of Tacoma has decided to ask for bids for the dredging of channels and slips in the tide flats recently purchased. The water frontage is 3,000 feet and the depth 4,500 feet. The site will provide a berthing place for fifty 500-foot steamers. The present waterway will be dredged to 35 feet depth. An open pier 1,200 feet long and 226 feet wide, and a transit shed 1,000 feet long and 180 feet wide with full equipment, will be the first unit constructed.

Port Improvements, Milwaukee, Wis.—Lieut. Col. Edward H. Schulz, engineer of the Milwaukee port district, has announced plans for improvements. It is proposed to repair east revetment at Grassy Island, Green Bay, Wis., continue repairs to revetments at Sturgeon Bay Canal, Wis., and Waukegan, Ill., and to repair piers and revetments at Grand Haven, Frankfort and Charlevoix, Mich. It is further proposed to complete concrete superstructure on south pile pier at Manistee, and construct caissons at Milwaukee for breakwater at Indiana Harbor, and to do necessary dredging for maintenance of harbors in the district.

Improvements at Navy Yard, Bremerton.—Among the improvements planned at the Puget Sound Navy Yard, Washington, to be proceeded with at once, are two drydocks, each 1,000 feet long, to cost $9,000,000; a fitting out pier 100 by 1,200 feet, $1,500,000; extension piers 4 and 5, 700 by 80 feet, $896,000; one merchandise pier, 125 by 1,200 feet, $1,200,000; 22,200 feet approach and ladder car storage track, $133,200; S. C. S. storehouse, 260 by 500 feet, $3,120,000; a total expenditure of $15,849,200. Other water front improvements to be considered later, aggregating $9,370,000 in cost include two 475-foot drydocks at $750,000 each; two 2,000-ton marine railways at $250,000 each; two merchandise piers, 30 by 1,200 feet, $3,850,000; 350 gross ton fitting-out crane, $1,000,000; and two auxiliary fitting-out cranes 5-10-ton, $120,000.

SHIPPING DEVELOPMENTS

Steamship Line, Georgetown, S. C.—Georgetown & Conway Steamboat Line, Inc., capital $15,000 has been organized by Joseph Schenk, E. W. Kaminski and F. D. Rosa.

Freight Line, Portland, Ore.—A monthly freight service between Portland and the Hawaiian Islands has been inaugurated by Parrott & Company, who have offices in San Francisco and a branch office in Portland.

Steamship, Holland.—The Holland America Line has begun the building of a new Staatendam to replace in its passenger service a vessel of the same name, sunk during the war. The vessel will be of 30,000 tons.

Portland, Me.-Mediterranean Service.—Announcement has been made that the White Star-Dominion Line is to establish a freight service from Portland to Mediterranean ports, the first sailing to be early in February.

Direct Line from Halifax, N. S., to Brazil.—The Marine Navigation Company of Canada will operate a direct line of steamers between St. John, N. S., and Halifax, N. S., and Brazilian ports, with five 5,000-ton vessels now under construction.

Steamships to be Returned, New York.—Tht Southern Pacific. Old Dominion and Ocean Steamship lines will be returned to their owners on March 1, after being under control of the United States Railroad Administration for twenty-six months.

Navigation Company, Peru, S. A.—The Chungwa Navigation Company, Ltd., has been inaugurated by Peruvian and Chilean merchants to provide a freight service between the west coast of South America and China, to stimulate the nitrate trade.

New Steamship Line, Boston.—The Patterson-Wylde Line will operate a line from Boston to Manchester, England. A steamer has been allocated to the company by the Shipping Board and others to maintain the service have been assured. The first sailing is to be about February 10.

Inter-Island Steamship Line, West Indies.—Cuban capital will organize an inter-island line to operate seven or eight steamers between ports for passenger and cargo service, according to J. A. Marques, Jr., steamship broker of Havana. Rafael Doniphan, Havana, is director of the new line.

Tanker Company, Dover, Del.—The Union Oil Steamship Company has been incorporated with capital stock of $50,000,000. The incorporators are M. L. Rogers, L. A. Erwin and W. G. Singer of Wilmington. The corporation is a subsidiary of the Union Oil Company and will take over the navigation work of that company.

Freight Service, New York.—The Dollar Steamship Company, which recently purchased a large tract of water front in the Hunt's Point section of the Bronx, is establishing an office at 44 Whitehall street, New York, and will operate a freight service from this port to ports of the Orient, beginning within hte next six weeks.

New Steamship Company, Brownsville, Tex.—The Rio Grande Gulf Steamship Company, recently organized, with D. A. O'Brien as president, will establish a line of passenger and freight steamships between Point Isabel and Tampico, Mexico, about February 15. The first ships for the proposed line were recently purchased in New York.

Steamship Line, Boston, Mass.—Rogers & Webb, of State street, will operate a line to Avonmouth and Hull, England, a 5,400-ton steamer having been allocated to the concern by the Shipping Board, with assurance of other steamships of equal tonnage in the near future. The first fortnightly sailing will be about the midle of February.

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Fig. 1.—Schooner Yacht *Elfay* (formerly the *Katoura*) Fitted with Diesel Electric Auxiliary Power

Diesel-Electric Drive for Yacht Elfay

BY REX W. WADMAN

For a long time the merits and demerits of electrically driven ships have been discussed and many theories have been expounded touching on the efficiency, convenience and dependability of electric drive in comparison with other propulsive powers. It has remained, however, for Mr. Russell A. Alger, of Detroit, Mich., to put these theories to definite trial on a large scale in the field of yachting, and this article briefly describes the equipment and operation of the first Diesel electrically-driven yacht in the world.

AMONG the vessels in which Nathanial G. Herreshoff, the famous naval architect of Bristol, R. I., designer of the successful America cup defenders, takes great pride is the schooner yacht *Elfay,* originally named the *Katoura,* which he designed in 1913 and completed a year later to the order of Robert E. Tod, of Rochester, N. Y. The vessel is of 313 tons gross, 162 feet long overall and 115 feet on the waterline, with a beam of 30 feet and an extreme draft of 21 feet 2 inches. She was originally built as a sailing schooner only, and as such was a contender in a number of long-distance races during 1914, 1915 and 1916. From stem to stern this boat was one of the most elaborately equipped and outfitted yachts ever built. The stateroom accommodations are truly luxurious in their roominess, furnishings and appearance.

About two years after her launching the *Katoura* was sold to Mr. Russell A. Alger, but, owing to the exigencies of the war, was little used and it was not until last fall

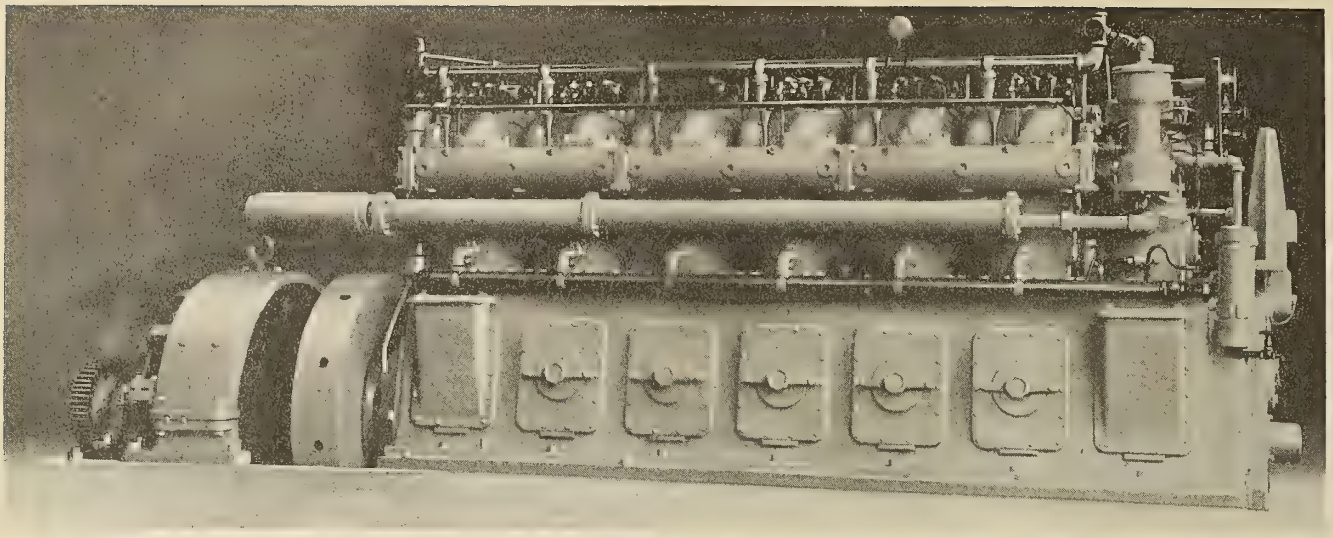


Fig. 2.—Side View of Winton Diesel Oil Engine, Model W-54, Bore 7½ Inches, Stroke 11 Inches, Direct-Connected to Westinghouse Generator as Installed in the *Elfay*

that Mr. Alger decided to put her into commission again. Before doing so he planned to install sufficient power to give the vessel a speed of eight or nine miles an hour without sail. To accomplish this result Mr. Alger decided on rather a radical departure. Away back in ancient history Mr. Alger bought the first 2-cylinder car that Alexander Winton, of Cleveland, built for the market, and since that time he and Mr. Winton have been very close friends. As Mr. Winton has often talked to him about the possibilities of electric drive for yachts, it was but logical that Mr. Alger should be again the first man actually to purchase from Mr. Winton the latest of his innovations.

Mr. Winton and his engineers were given practically carte blanc to work out a complete Diesel electric drive for the *Katoura,* now rechristened the *Elfay,* and as the result of the plans drawn up and the details worked out the installation now consists of the following: A six-cylinder Model 54 Winton Diesel oil engine, bore 7½ inches, stroke 11 inches, rated at 115 horsepower, direct-connected to a 75-kilowatt Westinghouse generator, which in turn is direct-connected to a 9-kilowatt Westinghouse exciter. The Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., actively co-operated with Mr. Winton and his engineers in developing the electrical part of the installation, and a great deal of credit must be extended to the Westinghouse people for the very complete and efficient manner in which their part of the installation was carried out.

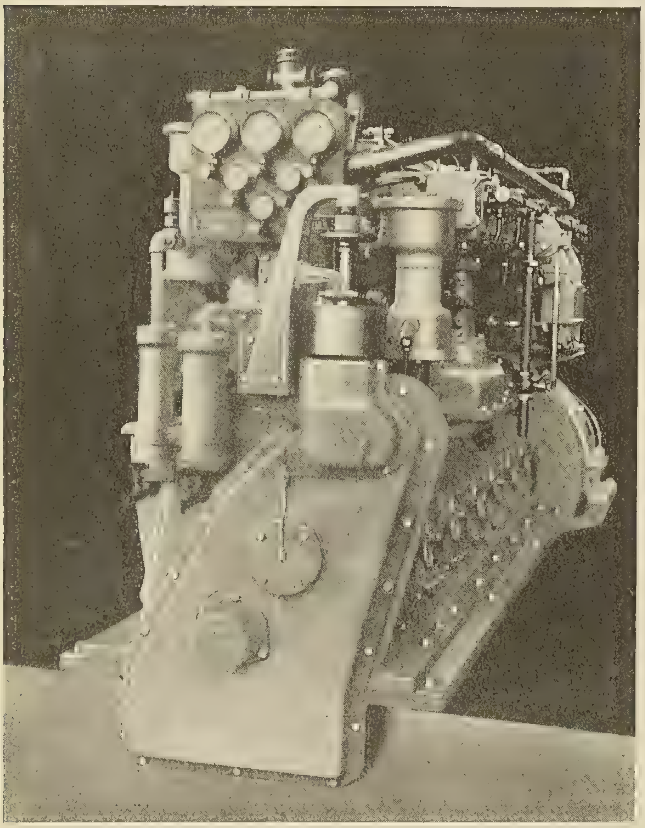


Fig. 3.—End View of Winton Diesel Oil Engine Which Was Installed in the *Elfay*

With the Winton Diesel oil engine and the Westinghouse generator as a nucleus, this entire ship is operated and controlled by electricity; no steam whatever is used or is required.

Electrically-Driven Auxiliaries

The big winch up forward, used for handling the anchor and in case of necessity for handling the sails, is operated by a 10-horsepower electric motor. Amidships two additional electric winches of 4 horsepower each are used for hoisting and lowering the sails. The boat throughout is heated by electricity, lighted by electricity and all cabins, etc., are supplied with electric fans. A ½-kilowatt wireless set is installed aft. Down in the engine room everything is operated electrically. There is a one-ton ice machine operated by a 7½-horsepower electric motor, a water pump, a bilge pump, and an oil pump all electrically driven, a ¾-horsepower air pump supplying fuel to the oil range in the galley, and an electrically-operated grinder and drill for necessary repair work. All bilges are kept ventilated by electrically-operated motors. The engine room itself is ventilated by a 1-horsepower electrically-operated fan. The Model W-18 Winton air compressor in the engine room is likewise operated by a 12½-horsepower electric motor.

In addition to the main generating plant there is an auxiliary generating set consisting of a 25-horsepower Quayle oil engine connected to a 15-kilowatt generator. This is purely an auxiliary outfit used to charge a set of Philadelphia storage batteries when the boat is lying at dock for any length of time.

The installation of storage batteries is a very elaborate and complete one and gives a rated capacity of 60 amperes

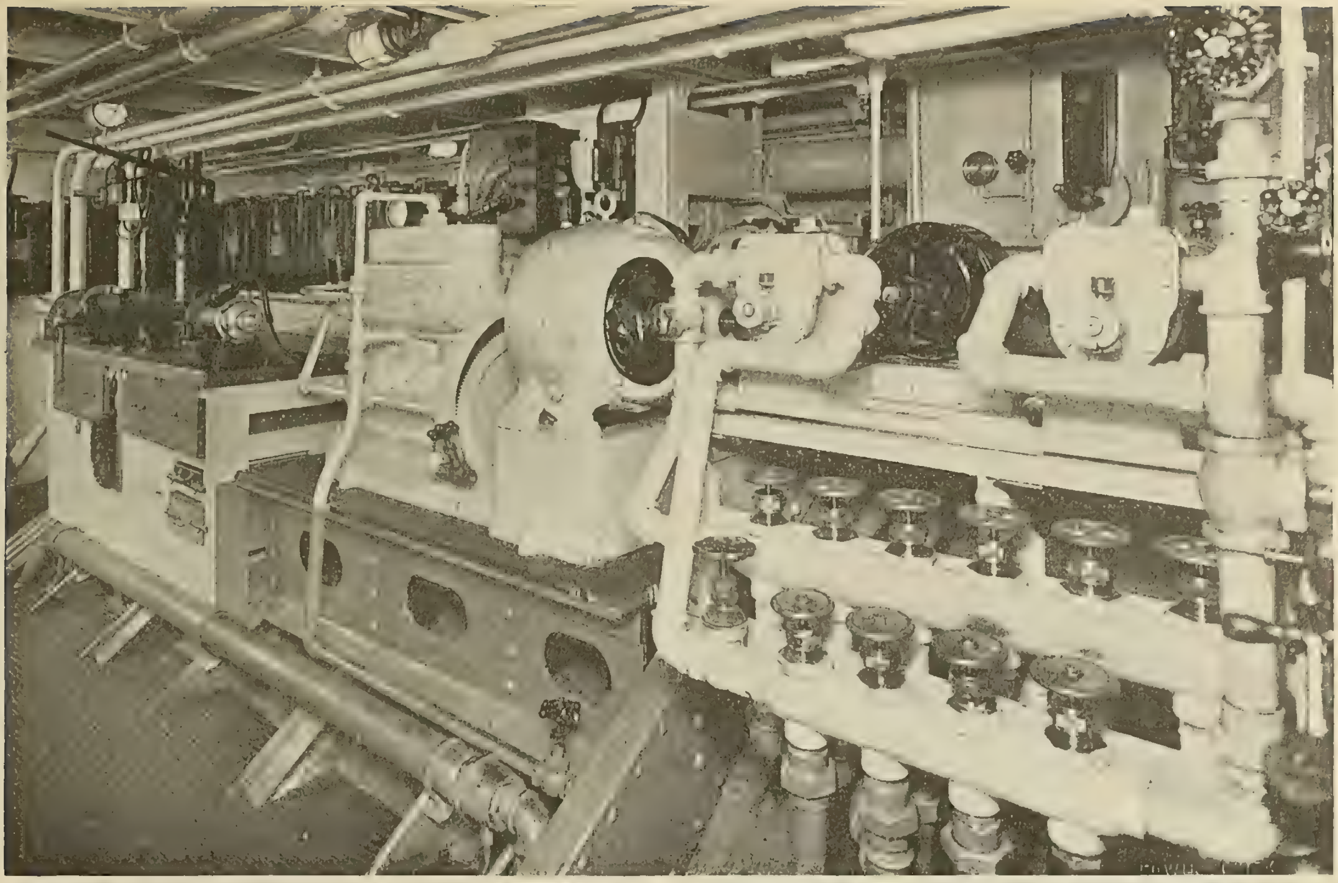


Fig. 4.—Electrically-Driven Auxiliaries in the Engine Room Include Oil Pump, Water Pump, Bilge Pump and Model W-18 Winton Air Compressor. Work Bench Fitted with Electrically-Driven Grinder and Drill. Installation of Philadelphia Storage Batteries in the Rear

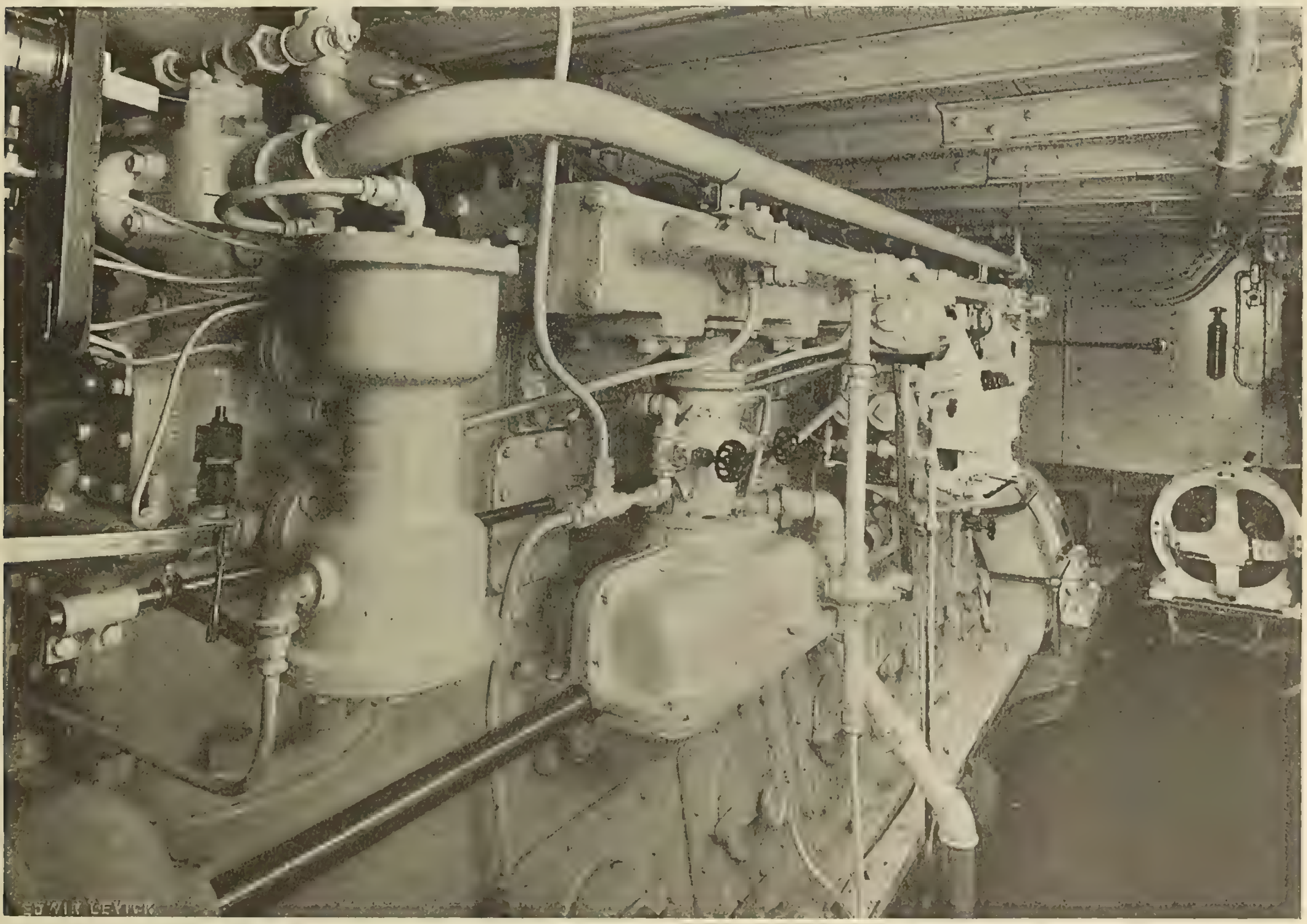


Fig. 5.—Engine Room, Showing Winton Six-Cylinder Diesel Oil Engine Direct-Connected to Westinghouse Generator with Chain-Driven Exciter to the Right. The Whole Engine Room Is Finished in White and the Entire Lack of Grease or Oil Presents a Striking Contrast to the Usual Ship's Engine Room

an hour for five consecutive hours. All requirements of the boat outside of the actual propulsion through the water can be supplied by this battery for two complete days without recharging.

At this point in the article it may be of value to repeat verbatim a report made to the owner by J. S. Walters, chief engineer of the *Elfay:*

The Chief Engineer's Report

"The electric drive as installed on the schooner *Elfay* consists of one 125-horsepower Winton Diesel engine and electrical equipment supplied by the Westinghouse Electric and Manufacturing Company. The engine is of the full Diesel type, four-cycle, six-cylinder, running at 425 revolutions per minute, equipped with a very sensitive governor that in turn controls the amount of fuel fed to the engine from an equally sensitive fuel pump.

"These two features are very essential and will hold the engine at almost constant speed under all conditions. In fact, the variation of speed from full ahead to full astern or from full astern to full ahead is about 20 revolutions per minute. This engine is direct-connected to a 75-kilowatt generator and also drives a 9-kilowatt exciter by means of a noiseless chain. The exciter turns at 900 revolutions per minute. The motor and generators are both separately excited from the exciter, the motor carrying a full field at all times. The generator field is strengthened, for going either ahead or astern, from on deck by means of a controller, which is connected to a rheostat below deck.

Fig. 6.—A "Close-Up" of the Control Station. From This Spot the Officer of the Deck Has Complete and Instantaneous Control of the Motive Power

"In the stop position there is no field in the generator but a full field in the motor; in the full ahead position there is a full field in both, and likewise a full field in both in the full astern position. The speed ahead or astern is varied according to the strength of the field in the generator.

"The exciter has a capacity of 9 kilowatts, and the motor requires about 2 kilowatts, and the generator 2 kilowatts, for excitation, leaving 5 kilowatts for auxiliary purposes, such as lights and power.

Fig. 7.—The Central Station—A Splendid Example of Electrical Installation and Control Worked Out by the Westinghouse Organization

"The main motor is installed as far aft as possible, giving a very short shaft. It is 90 horsepower at 360 revolutions per minute, turning a 42-inch by 42-inch three-blade propeller, giving a speed of between 8 and 8½ knots.

"The control is very simple and very efficient, enabling the reversal of the engine from full ahead to full astern or vice versa in five seconds. It is simple, inasmuch as but a small portion of the exciter current is handled, and not the main current.

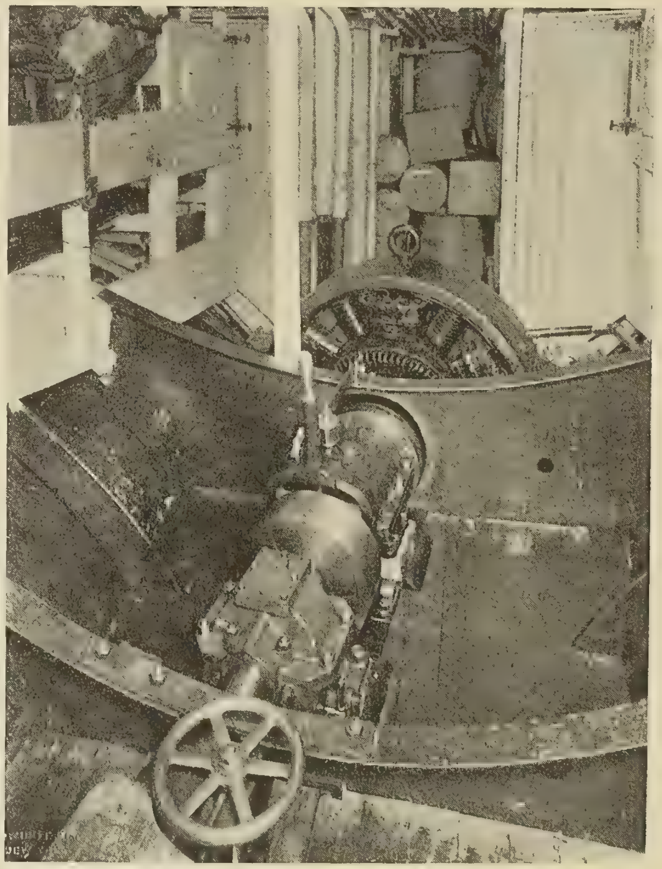


Fig. 8.—The 90-Horsepower Driving Motor Located in the Stern. Note Size of Bearings and Disengaging Clutch

"The actual operation consists of starting the engine idle, next throw the cam controller switch, building up the motor field from the exciter. Then the main breaker between the cam controller and motor. These are the only connections the engineer makes. The rest is controlled from deck. The deck controller is a small brass stand about 30 inches high. The handle has a swing of about 20 inches. By moving the handle one-half of the circle full ahead is obtained. By moving it the opposite way one-half the circle full astern is secured.

"A metering panel set in the deck house gives the voltage of generator, motor and exciter, the amperes used, also the revolutions per minute of the motor and generator. A duplicate set gives the same information in the engine room. It also indicates ahead or astern motion.

"The officer on deck knows at all times what speed he is making and can get the exact speed or power he wants either ahead or astern when he is in a tight place. He not only has control of the ship, but the control of the power aboard also."

Fig. 9.—Deck and Rigging of the *Elfay*

In Chief Walters' report the extreme simplicity of the control in this unique installation made possible by the Diesel electric drive is brought out in detail. The officer on deck himself is in complete control of the power unit. He does not have to rely on signals to the engine room with their necessary delays, etc. In addition, he has as much power available for reversing as he has for going ahead, and all within the uncannily short period of five seconds.

Here is an installation of a Diesel engine using fuel oil—the cheapest fuel obtainable—supplying that most flexible of all propulsive powers—electricity. Here is a compact, efficient, quiet and clean power plant which can be relied upon day in and day out, week in and week out. Such an installation can be operated at a minimum of expense for either fuel or labor as compared with any other type of power installation which could have been made.

The fueling situation is as efficient as is the balance of this remarkable installation. The boat has a capacity of 2,400 gallons of fuel oil, which gives her a cruising radius of 2,000 miles with a consumption of approximately 7½ gallons per hour. In addition, 360 gallons of lubricating oil are carried so that this boat can well be used for a world-wide cruise such as her owner plans to make. In fact, Mr. Alger is now on the way to Cuba, Bermuda, etc., and expects to return to New York in the spring and then plans to go to Europe down through the Mediterranean to the Suez Canal, through the Suez Canal to India, China and Japan and thence back to New York via Australia, Honolulu and the Panama Canal.

Such an installation as he now has in the *Elfay* makes such a trip both possible and safe, and it is not idle prophecy to say that many other yachts will follow the example set by the *Elfay* and will soon be equipped with Winton Diesel electric propulsion. It is interesting to note that efficient as this type of installation is in such a boat as the *Elfay* it is many times more efficient and desirable as an installation in our cargo carriers, where dependability and economy in power are so vitally necessary. In fact, it is a none too well-guarded secret that a number of cargo boats built by the Emergency Fleet Corporation in the hurry-scurry of war requirements are being converted from uneconomical and unprofitable steamers to economical and highly profitable electrically-driven boats, using the same principle of installation as that pioneered by Mr. Alger.

British Destroyer Wivern

Messrs. J. Samuel White & Co., Ltd., the well-known shipbuilders and engineers of East Cowes, Isle of Wight, completed and delivered their one hundred and twentieth steel war vessel and seventy-second steel torpedo craft on December 23. This was H.M.S. *Wivern* of the improved "W" class, which was laid down on August 19, 1918, and launched on April 15, 1919. She is similar in every respect to the *Witherington, Winchester, Vortigern* and *Vectis,* also built by the firm and now serving in the Royal Navy. She is of 1,450 tons displacement and 28,000 shaft horsepower.

The full power trials of the vessel off the south coast of the Isle of Wight were entirely satisfactory, when she attained an average speed of between 34 and 35 knots. The *Wivern's* twin screws are driven by a double set of Brown-Curtis geared turbines made by Messrs. White, and Mitchell thrust blocks have been installed. Steam is generated in three White-Forster watertube boilers. These, together with the oil fuel burning installations, all auxiliary machinery and the entire equipment, have also been constructed in the firm's engine works. The ship is capable of carrying some 400 tons of oil fuel, which will enable her to run about 1,000 miles at full speed.

Like the other destroyers of her class, the *Wivern's* armament consists of superimposed 4.7-inch guns fore and aft, with fire control and director gear, two anti-aircraft, high-angle, quick-firing guns on an elevated platform amidships, and two sets of triple-torpedo tubes mounted on revolving platforms.

As is customary with all White-built destroyers, the living accommodation for officers and crew surpasses that of most destroyers, the firm having consistently made this a special feature of their construction.

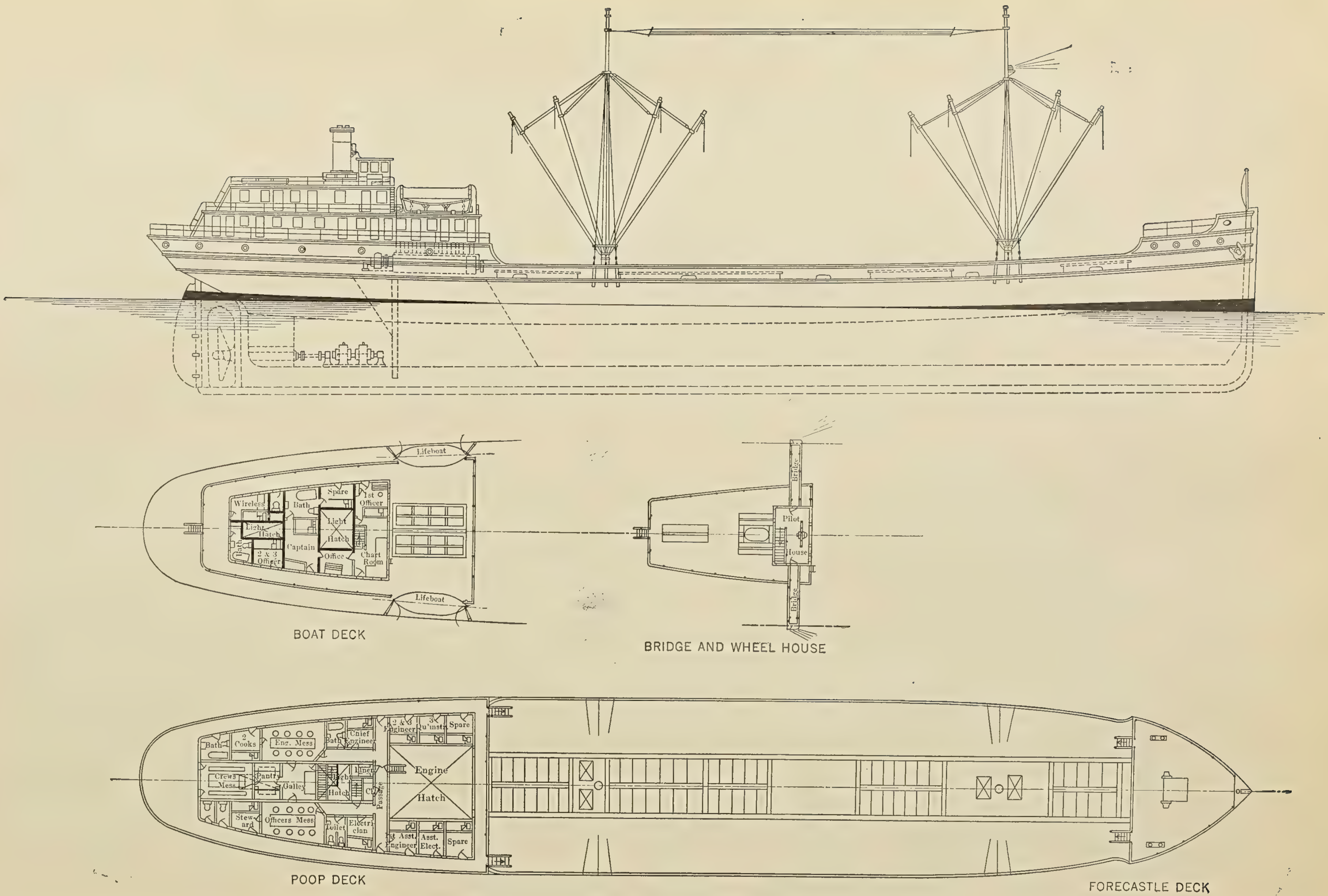


Fig. 1.—Outboard Profile and Deck Plans of Ferris-Type Hull Converted Into Motorship

Converting the Ferris-Type Wooden Hulls Into Diesel-Electric Driven Motorships

BY RENWICK Z. DICKIE*

The United States Shipping Board is offering many Ferris-type hulls at an attractive price and many shipping men are interested. This proposed Diesel-electric drive provides a very satisfactory method of converting these hulls into economical and reliable motorships.

FROM a shipowner's point of view the value of a vessel is decided by what she can earn as an investment. To analyze this value it would be necessary to consider the original cost, reliability of the hull and machinery, the maximum economical speed, the largest amount of cargo that can be carried, and, also, the question of easy loading and discharging and the economical operation with a large cruising radius.

In order to obtain the services of the best men for the operation of a ship, it is necessary that the officers', engineers', and crew's accommodations be of the best, so that the men who operate the ship will look upon her as their home, especially when the vessel is adapted to long cruises.

From the operating engineer's point of view, the engine room should be light and airy for comfortable work.

The Winton Engine Works, of Cleveland, Ohio, in collaboration with the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has taken up the matter of a Diesel-electric drive and is manufacturing direct-connected stationary engines for this purpose which are light enough to allow the main power plant of the vessel to be placed on deck. As many units are used as are necessary for the power required, and engine parts would be interchangeable, so that only one set of spares need be carried.

In the Ferris type of hull there is between the top of the keelson and the center of the propeller shaft a distance of only three feet, and with this fixed distance a motor with an external diameter of six feet only can be used. Such machines can be built for direct connection to the propeller shaft, or, if higher speed motors are desired, they can be used with gearing. The use of gearing may slightly reduce the weight, but, on the other hand, it is an additional piece of apparatus that requires attention. It is considered that good engineering requires the simplest possible operating equipment, and the use of a direct-connected motor is proposed. Provision would be made to facilitate the removal of the tail shaft by simply raising the top of the motor casing and the armature.

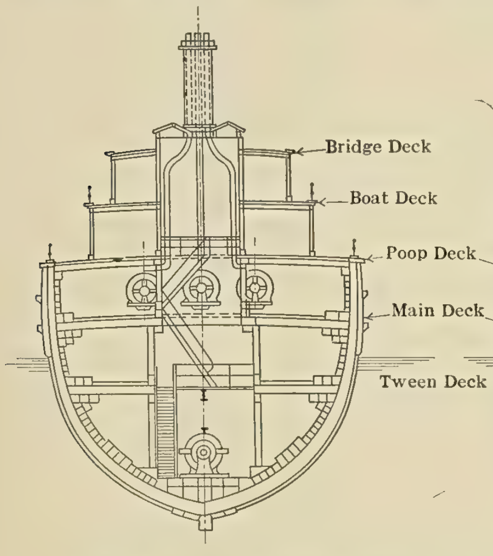


Fig. 2.—Section Through Motor Room

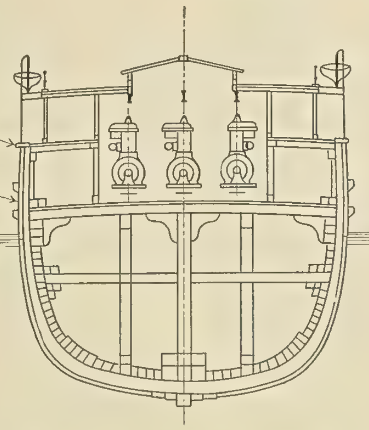


Fig. 3.—Section Through Engine Room

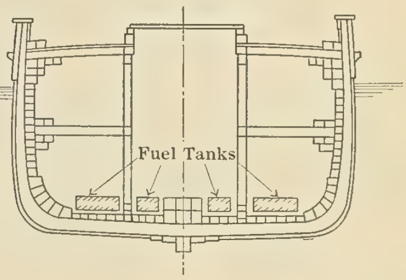


Fig. 4.—Section Through Cargo Hold

ALTERNATING VS. DIRECT CURRENT

In the case of electric marine drive with a steam turbine as a prime mover, alternating current has been used for transmitting the power from the generators to the driving motor. In case of high-powered installations, this system has advantages, and if turbines are used we are practically limited to it by the fact that direct-current generators cannot be built to run at the speeds required for turbine economy. In the case of Diesel engines, the speed of the prime movers favors direct-current generators, and the requirements of low-speed propelling motors present no difficulty, whereas with alternating current the slow-speed propelling motor is very difficult to build and does not contain desirable characteristics. The use of direct current eliminates any necessity of varying the speed of the prime movers and it makes possible the utilization of the full power of the engines, independently of the speed of the propeller. With an installation using three generators, for instance, one might be shut down and the motor then run at the proper speed to give two-thirds power, whereas with alternating current the speed of the prime movers would have to be reduced and this would, of course, proportionally reduce the available power.

With direct current the speed of the motor can be varied anything from zero to the maximum required revolutions and in either direction by simply regulating the field of the generators, and it will not be necessary to handle the main

* Naval architect, San Francisco, Cal.

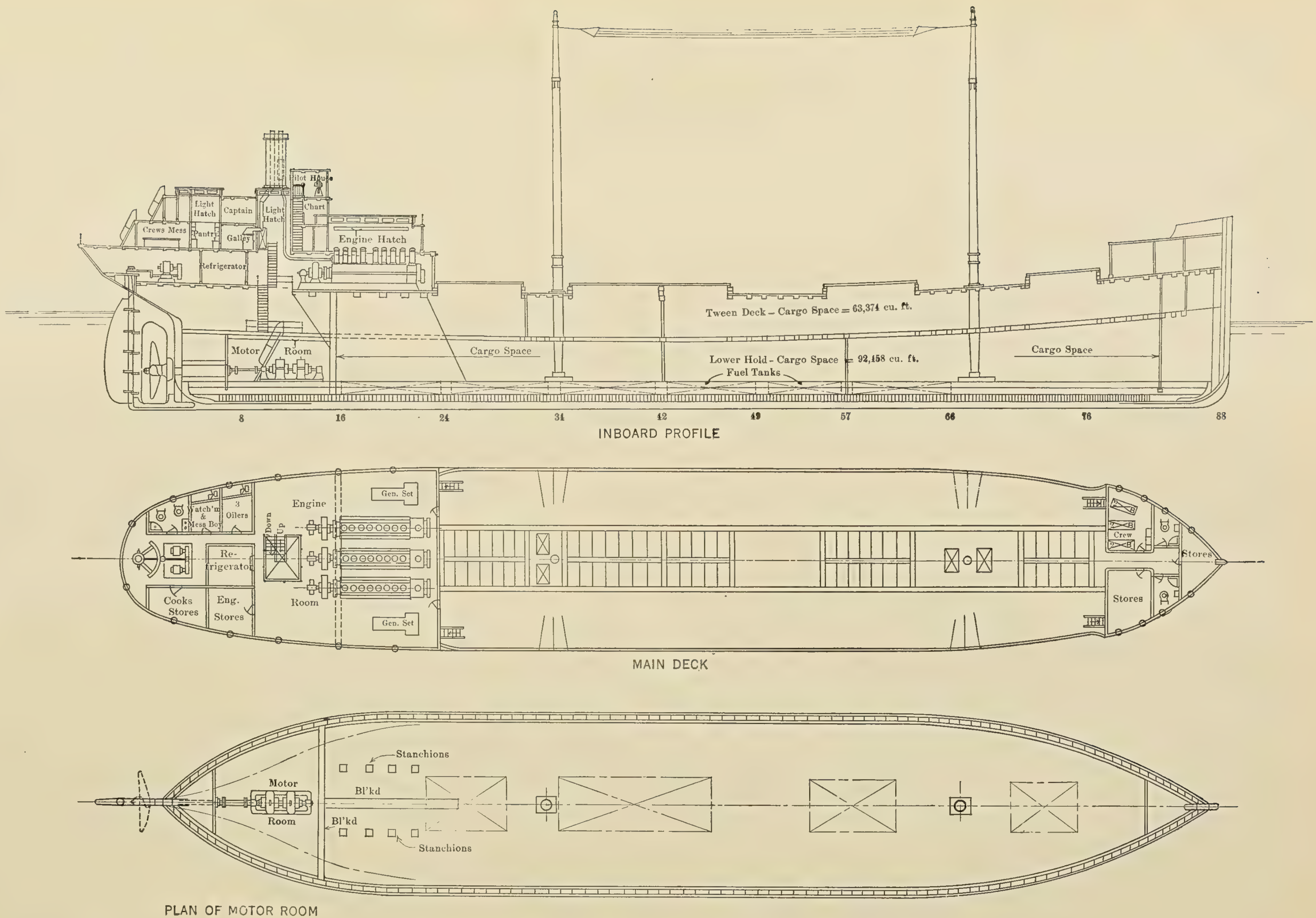


Fig. 5.—Inboard Profile and Deck Plans, Showing Machinery Arrangement of Converted Ferris-Type Hull

current. Due to this characteristic, the controlling equipment is very small and of light weight and can be located anywhere that may be convenient and be operated from the pilot house if so desired.

It may be objected that machinery using direct current is not as reliable as that using alternating current. In this connection it may be pointed out that in some of the most important electrical applications where reliability is of the utmost importance, direct current is applied, as, for instance, reversing blooming mills in steel plants, where machines capable of carrying loads up to 20,000 horsepower are in daily use, and in the use of high-powered electric locomotives such as are used in the Pennsylvania tunnel in New York and also on the Chicago, Milwaukee & St. Paul mountain division.

Direct Current for Auxiliaries

Direct current offers easy control and there are many advantages in its use for auxiliary machinery. Westinghouse experts propose its use with a complete electrical installation for all engine room auxiliaries and deck machinery, so controlled and wired that any one of the three main driving units may be used while in port to furnish all the power necessary for the operation of cargo winches and windlasses. Some time ago a test was made to ascertain the cost of fuel for handling 1,000 tons of cargo; using coal, it was $12, oil $7, and electric current $2.

In comparing this electric installation with propulsion by steam, it is assumed that two first-class electricians can properly care for the plant, and that their wages would just offset the wages of the firemen in the steam plant.

Figs. 1-5 illustrate a Ferris hull plant of this type, with the engines placed on deck, supported by a heavy centerline and 'thwartship bulkhead just forward of the motor compartment, leaving almost the entire hold space for cargo. The fuel tanks could be placed alongside of the keelson the entire length of the ship, giving a decided advantage in trimming when the ship is running light.

Commercial Gain of Diesel-Electric Drive

In order to illustrate the commercial gain of a Diesel-electric drive, placed in a wooden Ferris hull, a comparison will be given between two ships of this type, operating on the west coast, using available freight rates and charges, one vessel being equipped with a steam oil-burning plant with 1,400 indicated horsepower, and one equipped with an electric plant, giving the same effective horsepower at the propeller.

The Ferris type ships have a length overall of 281 feet 6 inches, a length between perpendiculars of 268 feet, a beam of 46 feet, and a depth of 26 feet. For comparison we will take the Ferris ship with watertube boilers and a triple-expansion engine with cylinders 19 inches, 32¼ inches and 54 inches diameter by 42 inches stroke, operating at 90 revolutions per minute.

Cargo-Carrying Capacity

Former operators of these vessels say that as coal burners they carried cargoes varying from 2,700 to 3,000 tons, but with oil they should carry at least 3,400 to 3,600 deadweight tons with the same cruising radius and have a sea speed of ten knots. As coal burners they have averaged between eight and nine knots, as in many instances they were hard steamers; but, as it requires less heating surface for oil, this defect would probably be remedied and they could be operated fairly economically.

Owners operating vessels of this size on the west coast have gone through their books and made a statement of value per deadweight ton for the last year, which is based on the total amount of freight carried, the amount received for this freight, and the expense of operating a ship of this size as an oil burner over a period of one year. By the following data it will be seen that by installing the proposed electric drive a saving of 80 tons in the original machinery weight would be effected, and 220 tons of oil would easily give the vessel the same cruising radius.

	Diesel Electric Drive	Triple-Expansion Plant
Indicated horsepower	1,400	1,400
Weight of plant installed, tons	220	300
Fuel used per hour per horsepower pounds	.45	1.25
Fuel used per hour, barrels	1.9	5.4
Fuel used per day at sea, barrels	45.6	129.6
Fuel used per day in port, barrels	8	26
Lubricating oil per day at sea, gallons	40.3	7
Lubricating oil per day in port, gallons	8.4	3
Lubricating oil per year in barrels	278.2	52
Cost lubricating oil per gallon	$0.29	$0.43
Cost lubricating oil per year	$3,338.40	$939.00
Cost of fuel oil, per barrel	$1.85	$1.60
Cost of fuel oil per day at sea	$87.32	$207.36
Cost of fuel oil per day in port	$14.80	$41.60
Days at sea	270	270
Days in port	95	95
Water used per day for power plant, tons	...	3.75
Fuel used per day, tons	6.74	18.64
Weight of fuel carried, tons	220	650
Weight of water carried, tons	50	170
Cost of water per ton	$1.00	$1.00
Cargo carried in deadweight tons, tons	3,400	3,000
Cargo space, in cubic feet	155,832	116,000
Cargo space (40 cubic feet per ton), tons	3,900	2,900
Fuel used in one year, barrels	13,504	37,462
Water used in year for power plant, tons	......	1,125
Total cost of fuel, water and lubricating oil for one year	$28,321.40	$62,004.12
Net profits of ship based on steam plant economy at $50 per deadweight ton	$170,000.00	$150,000.00
Total net profits, including fuel saved	$203,682.72	$150,000.00

Over a period of a year in the operation of the vessel, taking the present cost of fuel and water, she would have an increased carrying capacity of 400 tons, and would net her owners about $56,082 additional, through the saving in coal, water and weight, or a net gain in the commercial efficiency of the ship of about 35.7 percent.

American Progress in Marine Refrigeration

BY J. F. FARISH

UNTIL five or six years ago very little had been done in this country in refrigeration of ships for meat carrying, although this class of work was well advanced in Europe. After the great war began it was found that ships capable of carrying cargoes of meat were in demand. The European plants, usually sought for the work, were busy on war work and America was looked to. The first fully-fitted ship to be completely insulated and fitted with machinery was completed in Brooklyn for the Italian Government. When the United States entered the conflict it was found that refrigerator ships were lacking. By this time a number of foreign ships had been changed to American registry, and the only refrigerated ships flying the Stars and Stripes were fruit carriers and one or two tramps that had been converted to meat boats for the South American trade by private owners.

Meat Carriers for the Army in France

When our army began to move across the Atlantic it became necessary to provide meat carriers to supply it. The Shipping Board designated a number of the ships under construction at shipyards throughout the country and gave contracts to refrigerating machinery manufacturers and insulating companies to fit them for the new service.

Ships just launched, but uncompleted, in yards at Chester, Pa., New York, Baltimore and Oakland, Cal., were

given over to the refrigerating engineers, with the result that the United States produced meat carriers equal to, if not surpassing, those put out by our Allies.

To convert a regular cargo ship into a meat carrier requires several months. It has been the practice of the Shipping Board to install two or three steam-driven machines, each of fifty tons capacity, on a ship, according to the space refrigerated. On a few of the ships ammonia, which is almost exclusively used ashore, was used, but in the majority of cases CO_2 (carbon dioxide) machines were installed. While the working pressure necessary for ammonia is less than 200 pounds as compared to 1,200 pounds for CO_2, the danger of a leak in the system and injury from ammonia fumes is greater than with CO_2. From a standpoint of safety to the engine room crew, and consequently to the ship herself, CO_2 installations find much greater favor among marine engineers and architects.

Refrigerating System

The refrigerating system on a meat carrier consists of the machine, or compressor, which is the heart of the plant, and the cold compartments where the meat is stored. Connecting these sections and completing the arrangement are condensers, pumps, coolers, tanks and several miles of piping, which covers the meat compartments completely on the side walls and ceilings.

The small amount of headroom available aboard ship makes it necessary to provide a specially designed low horizontal compressor, driven in tandem or cross compound by a steam engine. The refrigerant, CO_2 or ammonia gas, is compressed to the required pressure and is led to the condensers, over which is circulated cold water. In the process of compression the gas becomes hot. As the water abstracts the heat the gas condenses and becomes a liquid under pressure. As soon as the refrigerant is released to a lower pressure it evaporates into a gas again, but in order to do so it takes the heat from whatever surrounds it. In this case the evaporating refrigerant expands in piping submerged in a tank of brine and cools the brine. This apparatus is called a brine cooler. It is possible to obtain a temperature of brine considerably below zero.

Steam-driven pumps force the cold brine out through the coils placed in the meat compartments. The circulating brine picks up any heat that may have leaked into the compartments and carries it back to the brine cooler. By an elaborate system of thermometers it is possible to tell at just what part of the ship the greatest heat leakage exists, if there is any.

Insulation

In order to provide against the admission of heat in the cold chambers, the compartments are insulated—that is, they are made into huge ice boxes or refrigerators. The holds of the ship where meat is to be carried are lined completely—top, bottom and sides—with a non-conductor of heat. This is packed between the skin of the ship and sheathing and is approximately one foot thick. It may be of either cork or mineral wool, a rock product made especially for this work. For one ship about seventy-five carloads of mineral wool and ten carloads of lumber are used.

The results have been most satisfactory. The usual working temperature is 15 degrees F. On one voyage of a ship built and fitted in New York harbor temperatures not exceeding 0 degree were carried by orders of General Pershing. Furthermore, the cargo was discharged at Rotterdam with the ship's hatches open, under orders that at no time during the unloading should the temperatures in the compartment rise above zero. This was successfully carried out.

Three steamers fitted in the past two years now carry 12,000,000 pounds of meat each on a single voyage; eight ships carry 7,000,000 pounds, and eight carry 5,000,000 pounds. As it is figured that an individual will consume about one-half pound of meat a day and the round trip of a meat ship takes in the neighborhood of two months, it can be estimated how many people can be fed by this fleet in a year.

For the past ten or fifteen years this country has been in the lead regarding small units for cooling ships' stores and making ice for use of the crews. For this purpose a large number of small ammonia machines has been installed in the stewards' departments on American ships and on British ships in American ports.

Motor-Driven Tanker

The motorship *Pinthis*, a sister ship to the *Bayonne*, is a steel tanker recently built by the Tank Ship Building Corporation at Newburgh, N. Y., to Lloyd's highest class and owned by the Sugar Products Company, of New York City. The *Pinthis* will be used in the coastwise molasses-carrying trade. The principal particulars of the vessel are as follows:

Length overall	216 feet 7 inches
Length between perpendiculars	208 feet
Molded beam	35 feet 6 inches
Molded depth	17 feet 4 inches
Radius of bilge	4 feet
Designed deadweight	1,750 tons
Designed draft	15 feet 3 inches
Main engine	500 brake horsepower
Bunker oil capacity	54.2 tons
Fresh water for boiler feed—	
Fore peak	44 tons
After peak	21 tons
Double bottom	32 tons
Drinking water, daily service tanks (2)	5.2 tons
Lubricating oil storage	200 gallons
Propeller, pitch	6 feet 3 inches
Propeller, diameter	8 feet 6½ inches

The speed attained during the trial trip of the vessel, which was held on November 14, was 9½ knots. The fuel consumption of the main engine was not ascertained definitely on account of the fact that the fuel for the main engine, as well as for the donkey boiler, had to be

Fig. 1.—Stern View of Motorship *Pinthis*

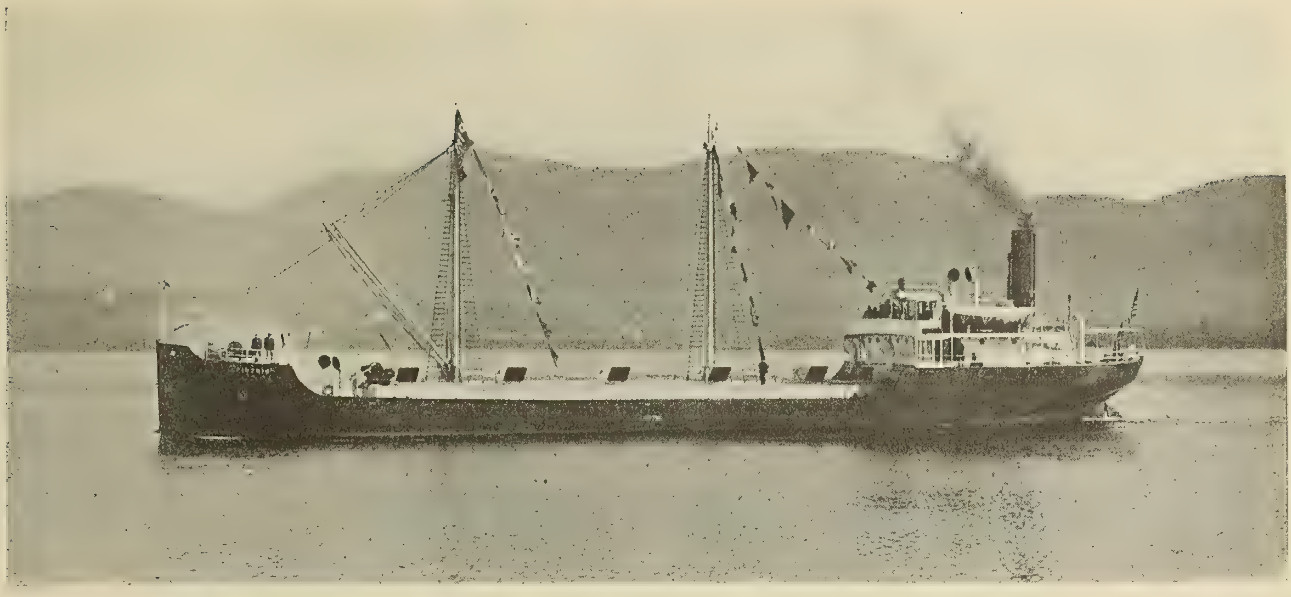


Fig. 2.—Motorship *Pinthis*, of 1,750 Tons Deadweight, for the Coastwise Molasses-Carrying Trade

taken from the same tank, but it was gaged to about .52 pound per brake horsepower per hour.

All accommodations, with the exception of the deck crew's quarters in the forecastle, as well as the engine room, are located aft. The arrangements and details are well considered and carried out in a practical and convenient way. The engine room is large and light, and an ample working space is provided around the main engine and all the auxiliaries. The main engine is a 4-cylinder, 500-brake-horsepower Bolinder engine of the surface ignition type with air injection. The engine is direct reversible and runs at a normal speed of 160 revolutions per minute.

Auxiliaries Are Steam-Driven

All the auxiliaries, except the reserve air compressor, are driven directly or indirectly by steam supplied at a pressure of 120 pounds per square inch from a boiler built

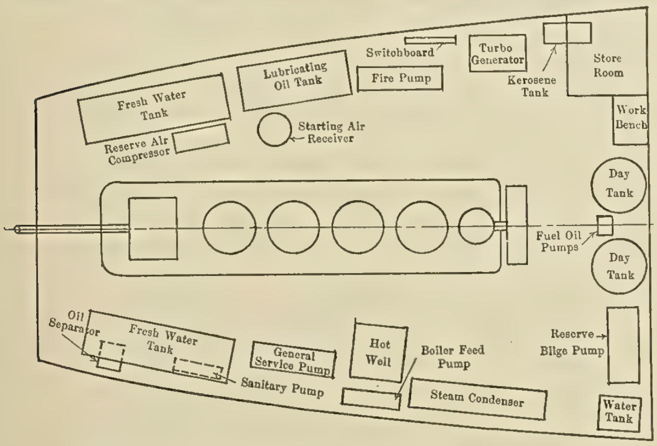


Fig. 3.—Plan of the Engine Room of the *Pinthis*

by the Vulcan Iron Works and fitted out with a "White burner" located on the upper deck forward of the engine room bulkhead.

In the engine room the service tanks are connected up to the main engine as well as to the boiler. An electric-driven rotary pump is used for pumping fuel oil from the bunker to the two service tanks. A direct-acting duplex steam pump is used as reserve bilge pump. The daily bilge pump is a standard equipment with the main engine. An electric-driven De Laval oil separator is provided which in a very short time is able to purify all waste oil collected by a pan. In this way the oil consumption is brought down to a minimum without cutting down the lubricating oil supplied to the engine.

The reserve air compressor is driven by a 3-horsepower, direct-connected gasoline (petrol) engine. This air compressor is used very exceptionally, as, for instance, after repairs to the starting air receiver. The electric plant consists of a single-stage turbine direct-connected to a 10-kilowatt, direct-current General Electric generator. The whole set is carried by two bearings only and manufactured by the Steam Motors Company, Springfield, Mass.

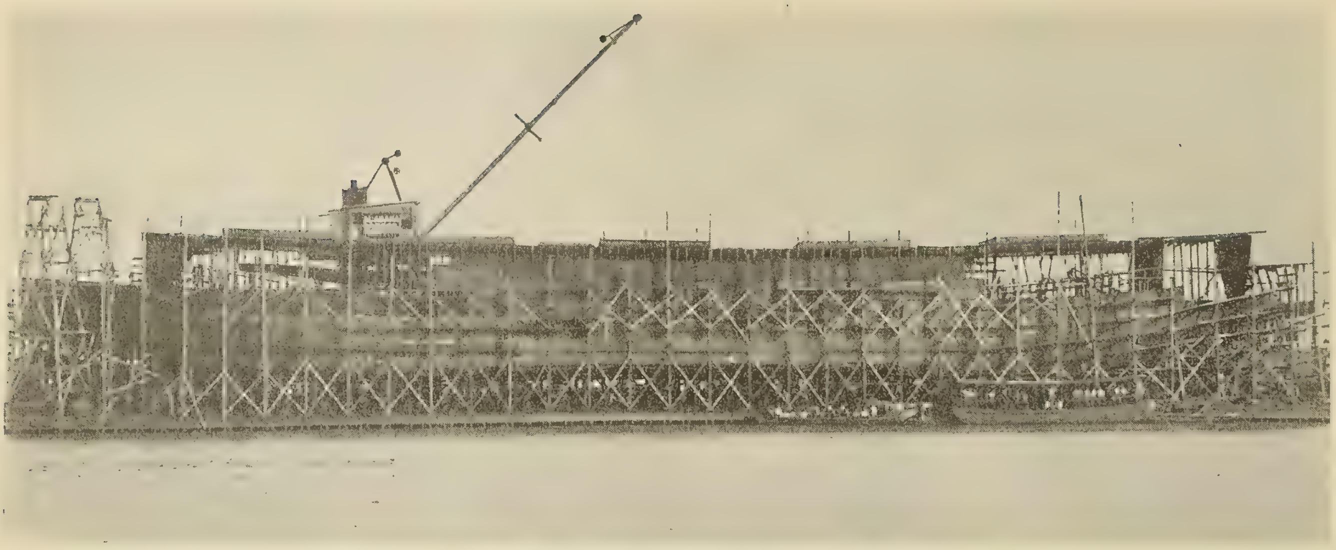
Fuel Bunkers

Forward of the bridge and bulkhead is a space of four feet to the first tank bulkhead. This space is divided by the centerline bulkhead and is used for bunker fuel oil. The capacity is about 54 tons. The bunker tanks are provided with heating coils and double piping to the service tanks. An expansion trunk 3 feet high and 18 feet wide starts from the bridge and bulkhead and is carried over the bunker trunk and all the cargo tanks. These latter comprise ten tanks, five on each side. Each tank is made tight, so as to allow carrying of various liquids at the same time. Each tank is provided with a heating coil, as this tanker will be used for carrying molasses.

Forward of the cargo tanks is the pump room. All the pumps are direct-acting steam pumps and the connections from the tanks are well carried out, so as to enable the emptying of one tank into any one of the others, as well as overboard. A small cargo room is also provided for forward of the pump room.

Piston and Valve Rod Packings

There are quite a lot of various makes of piston and valve rod packings in the market. They are of two kinds, soft and metallic. Again, there are two kinds of metallic packing, the self-adjusting and the rigid types. Half way between these there is a packing in which metal is used to make a sort of rope. This is semi-flexible. Now, it is bad to find yourself shipmates with something you do not understand, so when off watch next time just write to all the makers of packing and get their catalogues and read them with care, so you will know something about all the various types of packing. Knowledge is power, and to know more than the next man may be the means of your advancement.



Steel Coal Barge Under Construction at Mobile Shipyard

7,500-Ton Coal Barges for the Panama Canal

Two Steel, Sea-Going Vessels Built by the Alabama Dry Dock & Shipbuilding Company, Mobile, Ala., for the Emergency Fleet Corporation

UNDER the pressure of war emergency, many shipbuilding concerns were organized in this country and their plants laid out for the single purpose of building one type of ship on which they would specialize to the exclusion of all other work. This plan of production has proved successful in getting out one type of ship rapidly, but does not tend to produce the all-around organization necessary to take care of both new construction and repairs in every department of any type ship that comes along, such as many of the old-established shipyards have, and which can continually strive to improve.

The Alabama Dry Dock & Shipbuilding Company, of Mobile, Ala., was awarded a variety of war contracts which called for an all-around plant and organization, as can be seen by the following list of work which was carried out for the various government departments:

Government Contracts

A contract to repair and put into commission the interned Austrian steamer *Lucia* and to install in this ship the Donnelly buoyancy box installation, which was one of the first experiments made by the government in an effort to develop a non-sinkable ship as a defense against the submarine. This installation was fully discussed in a paper read by Mr. Donnelly before the Society of Naval Architects and Marine Engineers in the fall of 1918.

A contract to build for the Emergency Fleet Corporation two complete Ferris-type wooden ships, the *Alta* and *Banago*.

A contract to build and operate for the Shipping Board a 10,000-ton "Donnelly type" dry dock.

A contract to build for the Navy Department three sea-going mine sweepers, the *Swan, Whippoorwill* and *Bittern*.

A contract to build for the Panama Canal two sea-going coal barges of 7,500 tons deadweight each, the *Darien* and *Mamei*. The contract for these vessels was let through the Emergency Fleet Corporation.

All of this work was carried on at the same time, along with the regular work of dry docking and ship repairs, which is the company's principal business. At the same time a small wooden schooner was built by the company for private account.

All of these contracts have now been completed, except the two barges for the Panama Canal Commission, which were not to be built as war emergency ships, but to take care of the regular business of transporting coal to the Isthmus.

Details of the Barges

In these coal barges are incorporated all the details of construction and equipment that up-to-date practice requires, and they are complete ships except for the lack of propelling machinery. The barges are designed to be towed by the Panama Canal colliers *Achilles* and *Ulysses* and are fitted with powerful towing engines and means of ready communication with the colliers by wireless telephone.

The principal dimensions are as follows:

Length overall	352 feet
Length on the waterline	335 "
Molded beam	52 "
Molded depth	33 "
Sheer, forward	8 "
Sheer, aft	5 "
Draft at full load	26 "
Deadweight tonnage at load draft	7,500 tons

Built under a guarantee to carry 7,500 long tons of coal with all stores and provisions, besides 50 tons of coal for the donkey boiler, 80 tons of feed water and 3,000 gallons of drinking water, these barges are equipped ready for sea with a draft not to exceed 26 feet, at which the block coefficient is not to exceed 0.78.

The vessels are single-deck steel barges with inner bottoms throughout and with Simpson's top side ballast tanks through the cargo holds. They are built throughout to the American Bureau classification, with poop and forecastle decks, a steel flat forward and a steel flat aft for the donkey boiler, bunkers, pumps, etc. The holds are divided by six bulkheads forming the fore peak tank, five cargo holds and the after peak tank. There is a steel

deck house on the poop deck with pilot house and bridge, captain's stateroom, wireless operator's quarters and toilets. The officers and crew are berthed in the poop deck. In the forecastle there is an anchor windlass and towing engine and the paint and lamp lockers.

Launching of Coal Barge *Darien*

Rigging and Equipment

These barges are schooner-rigged with four wooden masts fitted with stay sail, fore, main, mizzen and jigger sails and equipped with wireless telegraph and wireless telegraph and wireless telephone for communication with the colliers that are to tow them, the wireless antennae being carried from the top of the mizzen mast over a top mast on the jigger mast and down to a short wireless mast on the poop deck.

The auxiliary equipment consists of the following machinery:

Deck

One 10-inch by 10-inch double-cylinder No. 11 American Engineering spur-geared windlass.

One 16-inch by 16-inch double-cylinder, size "F," Philadelphia towing machine.

One 8-inch by 8-inch double-cylinder, size "F," capstan.

One 8-inch by 7-inch double-cylinder American Engineering Company screw-geared steering engine.

Two 7-inch by 7-inch double-cylinder deck winches.

Engine Room Auxiliaries

One 12-foot 1⅝-inch by 11-foot 1½-inch Scotch boiler with 1,492 square feet heating surface.

One 500-square-foot surface condenser mounted over a 7½-inch by 9-inch by 9-inch by 10-inch combined air and circulating pump.

Fitting Out the Panama Coal Barge *Darien* at the Yard of the Alabama Dry Dock & Shipbuilding Company

One 6-inch by 3½-inch by 8-inch Blake feed pump.

Two 8-inch by 7-inch by 12-inch horizontal duplex bilge and ballast pumps.

One 6-inch by 4-inch by 6-inch horizontal duplex fire pump.

One 5-kilowatt General Electric generating set.

The barges are equipped with a complete system of inner bottom ballast piping, bilge suction piping, steam and exhaust piping on deck and fire lines and steam smothering system reaching all compartments.

The main hatch covers are all steel, hinged and operated by special tackle handled by the deck winches. The tank tops and bilges up to top of the bilge brackets are covered with a 3-inch layer of pitch and two thicknesses of 2½-inch heart yellow pine planking laid first course fore and aft and top course athwartships.

The inner bottoms, insides of topside ballast tanks and fore peak tanks, chain locker, coal bunkers, floors in boiler and pump rooms and after peak tank are coated with Hermastic primer applied cold and one coat of Hermastic enamel applied hot to a thickness varying from ⅛ inch to ¼ inch, according to the location.

Accommodations

The quarters arranged in the poop for a crew of 18 men are finished neatly in cypress with hard oil finish and white enamel overhead. There is also provided in the poop, besides the quarters for officers and crew, regular messrooms, toilets and bathrooms, galley, ice box, store room and linen locker, dynamo room and steering engine.

From the illustrations it will be seen that these barges are first class in design, workmanship and equipment throughout. The first barge was launched on September 30, 1919, and the second on January 1, 1920, from the same ways, making about 90 days on the second hull from the laying of the keel to launching. All of the hull material was laid out and fabricated by the builders in their plate shop, as were also the boilers. In fact, the vessels are built complete at the company's plant.

The specifications were prepared by the Panama Canal Commission and follow their standard practice. The plans were drawn by Kindlund & Drake, of New York.

Shipbuilding in Australia

THE second of the Australian standard ships, the S. S. *Delungra,* is shown in Fig. 1 about to leave the Walsh Island Shipyard, Newcastle, N.S.W., for the port of Sydney, some 60 miles distant, for docking purposes prior to undergoing her sea trials to the satisfaction of the Commonwealth authorities. This is the first of the six vessels contracted for by the State shipyard, the launching of which was mentioned in the July issue of this journal.

The *Delungra* left Sydney on October 9 for her deep-sea trials, on which an average speed of 12.128 knots was obtained throughout a continuous run of 3½ hours. The trials were very complete and proved highly satisfactory. The whole of the machinery, with the exception of some auxiliaries, was built at the Walsh Island Dockyard.

Fig. 2 shows a panoramic view of the shipyard at Walsh Island, Newcastle, with the *Dinoga* ready for launching and the hull of the *Dilga* on the right nearing completion. In the background a view of the Broken Hill Proprietary Company, Ltd. iron and steel works may be seen, from which the whole of the sectional material and a quantity of the plates are obtained for the building of these steamers. A quantity of fabricated material ready for the vessels can be seen in the assembling yards at the head of the building ways in the foreground of the illustration.

The S. S. *Dinoga* was launched on October 17. The ship is in an advanced state of construction. The boilers are already installed, together with all auxiliaries. The launching weight of the *Dinoga* was 1,660 tons. Particulars of these vessels have already been published, the principal dimensions being: Length, 331 feet; breadth, molded, 47 feet 9 inches; depth, molded, 26 feet 1 inch.

The keel of the fourth vessel was laid on the slip vacated by the *Dinoga* immediately after that vessel was launched. The management are now negotiating for contracts for two or three 12,800-ton vessels, the construction of which is to follow the standard vessels.

During the month of November, 1919, two more of the Australian standard type vessels were launched. The Walsh Island yard at Newcastle, N. S. W., launched their third ship, the S. S. *Dilga,* on November 15. The keel of

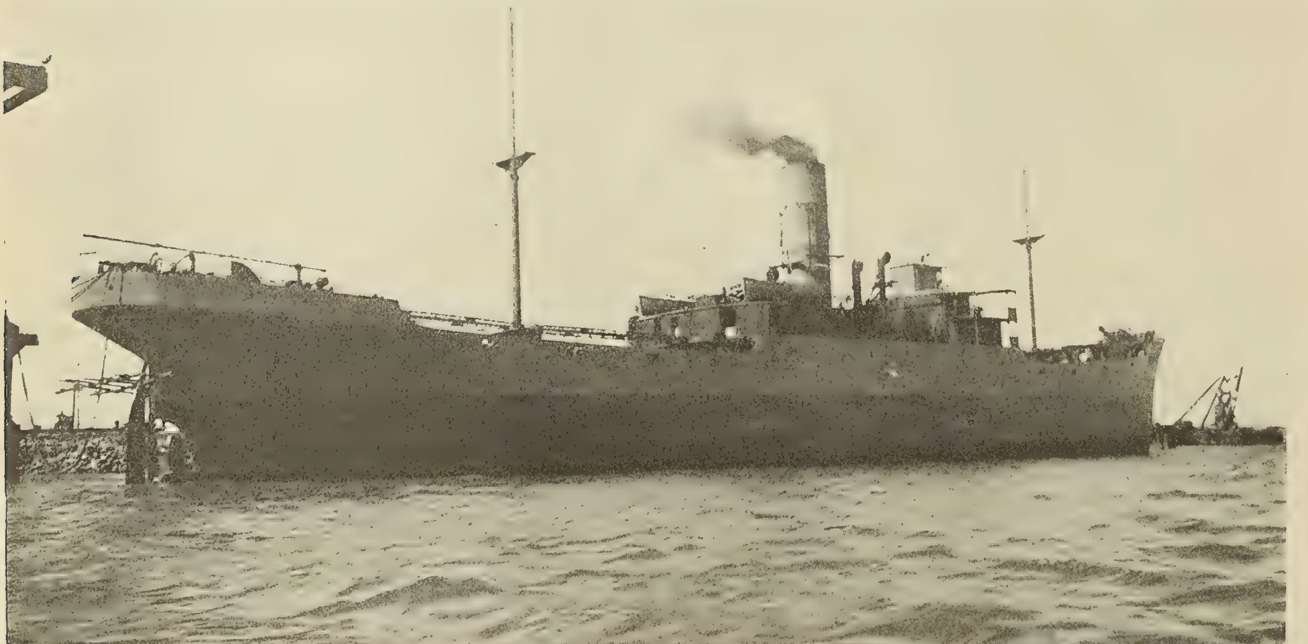


Fig. 1.—S. S. *Delungra,* the Second Australian Standard Ship Built at the Walsh Island Shipyard

Fig. 2.—Panoramic View of the Walsh Island Shipyard at Newcastle

the sixth and last vessel of the original contract was immediately laid on the site vacated by the *Dilga*.

The *Dumosa*, the second vessel to be constructed at the Williamstown Dockyard, was launched on November 25. Her length is 341 feet; breadth, 48 feet; depth, molded, 26 feet 1 inch. Built on the Isherwood system of longitudinal framing, she is of the single-deck type, with poop, bridge and forecastle, and is classed 100 A1 at Lloyds. Her hatches are exceptionally large, and she is provided with ample cargo-handling equipment, consisting of eleven winches and eleven derricks, one of which is a 20-ton derrick.

The captain and officers are berthed amidships, the engineers being on the bridge alongside the engine casings. The crew are berthed in the poop. All accommodations are roomy, with separate mess rooms for the firemen and sailors. Baths and wash rooms are also provided.

The deadweight capacity of the vessel is 5,600 tons, on a 21-foot 9-inch draft. The machinery consists of triple-expansion engines with cylinders 25, 41 and 68 inches diameter and 45 inches stroke, and three Babcock & Wilcox watertube boilers designed for 180 pounds pressure. The engines are being constructed by Messrs. Thompson & Company, of Castlemaine, Victoria. All the sectional material was manufactured in Australia.

The first two vessels completed, the *Dromana* and *Delungra*, have both completed their maiden voyage to Ocean Island and have given every satisfaction.

Marine Terminal and Harbor Engineering

BY H. MCL. HARDING*

WHILE terminal engineering, as applied to ports, can include harbor engineering, yet as the physical work of harbor engineering has in the past been a province of the army engineers, it might be well for harbor engineering of the United States to be separated from terminal engineering. In regard to foreign port development, it will then be necessary for all the port engineering work to be combined and under the charge of the terminal engineer.

In general, terminal engineering includes the plans for the quays, piers and their substructures, water depths in slips and at pierheads, the designs for the sheds, warehouses, railway tracks and their relative locations to each other. The length and width of the piers and quays, and elevations of these above mean low water, with the dimensions of sheds and warehouses, the length and number and radii of curves of railway tracks on the piers and quays, and the length, arrangement and leads of storage railway tracks, especially pertain to terminal work.

The types of all kinds of mechanical appliances, universal and special, their installation and methods of operation, should receive the utmost attention of the terminal engineer. There should be a careful study of the movements of the inbound and outbound cargoes, and the whole design should provide for elimination of congestion points, so as to secure the utmost speed of transference and handling.

The number and lengths of berths for the discharging and loading of ships, barges, lighters and scows, the dimensions and number of quay and pier units, the open piers with facilities and equipment, as well as the shedded piers, the required capacity of sheds per unit, the drayways, dray areas and approaches come under the head of terminal engineering. There must be provision for special industries and products, manufactured and agricultural, so that all may be loaded and discharged easily and quickly, and that the inbound freight may be assorted, distributed and tiered ready for the local drays or for the cars for further carriage or for transshipment to other vessels.

The transferring capacity per unit must be known, so that by multiplying this capacity by the number of units the capacity of the whole port terminal can immediately be determined. The total cubic holding capacity of sheds and of the long-storage warehouse capacity proportional

* Designing engineer, Harbor Commission, city of Milwaukee, Wis.

to the ships and the speed of flow of the freight between points must be determined relatively and with exactness. The extent and possibilities of co-ordination, especially as pertaining to the outbound freight, are not the least of the engineering decisions.

The above list might be greatly extended, but as enumerated it can serve as a basis for amplification. All permanent shore works of an operating terminal belong to terminal engineering.

Harbor engineering includes the construction and location of breakwaters, rubble mounds and harbor entrances, also the location of channels, of pier and bulkhead lines, dredging, the position of lighthouses, the collection of statistics as to water-level variations and tabulating them—in short, that work pertaining to harbors which the Federal Government has previously undertaken. With the work in and above the water, apart from the shore, the above may comprise the elements of harbor engineering.

A World's Dry Docking Record

WHAT shipping men concede to be the world's record in dry docking achievement was accomplished recently when the 30,000-ton floating dry dock of the Morse Dry Dock & Repair Company, of Brooklyn, N. Y., lifted the United States Shipping Board steamer *Minnesota,* which has a cargo capacity of 30,000 tons excluding her reserve bunker space, in only 25 minutes of actual pumping time. Not only was the *Minnesota* the largest ship that has as yet tested the strength of a floating dry dock, but the rapidity with which the lift was made is in itself a distinctive record. All sections of the six-section dock of the Morse Company were commissioned for this work.

Of twin-screw type and 630 feet long, the *Minnesota* was one of two sister ships built in America primarily as a cargo carrier for the Great Northern Railway. She now has accommodations for 2,400 steerage passengers. The propelling machinery of the *Minnesota* consists of two sets of three-cylinder, vertical, triple-expansion engines of the direct acting surface condensing type, with cylinders 29 inches, 51 inches and 89 inches in diameter. Her boilers, sixteen in number, are of the Niclausse water-tube type and were built by Stirling & Company. These were constructed for a steam pressure of 250 pounds per square inch.

Centrifugal pumps, circulating 7,000 gallons of water per hour through the ship's condenser, are driven by 10-horsepower motors. The ship's docks are supported by box-shaped girders. The *Minnesota* and her sister ship were the first vessels fitted in this manner and so classed by Lloyds.

The establishment of such a notable record followed close the lifting of another Shipping Board steamer, *Eastern Cross,* in 11 minutes' actual pumping time, and the American Army transport *Powhatan* in 22 minutes. The speed attending the raising of the *Eastern Cross* is remarkable in view of the fact that only three sections of the six-section dock were used and that the *Eastern Cross* held 4,000 tons of general merchandise when she was lifted. Only four sections of the dock were required to raise the *Powhatan,* weighing 12,000 tons.

Exactly 11 minutes after the pumps started the operation of getting the *Eastern Cross* out of water, workmen were busy erecting riggings and preparing to dismantle her broken rudder parts.

This quick and most efficient "first aid" treatment administered to this ship was given in a time of urgent need, for the vessel had sustained the broken rudder

The *Minnesota* Moored in the Morse 30,000-Ton Dry Dock Ready for Docking

when more than two days out at sea with her general merchandise cargo, bound for a European port. Her rudder rendered useless, the ship was buffeted about by winds and seas, and she made eight completed circles in a watch of as many hours. The rigging of a jury rudder was instrumental in getting her back as far as Sandy Hook after she had abandoned further attempt to reach Europe. Off Scotland light the Morse Company tugs *Dewitt C. Ivins* and *Anson M. Bangs* reached the vessel, towing her to the Brooklyn yards of the Morse Dry Dock & Repair Company.

The ship's weight, combined with her cargo, totalled close to 10,000 tons. While the new dry dock of the Morse Company is capable of lifting vessels 725 feet in length and of 30,000 tons, the raising of the *Eastern Cross* by only three sections of the dock has amply demonstrated that all six sections can give a large steamship an outside hull inspection in almost as short a space of actual pumping time.

As regards expediency, this big floating dry dock of the Morse Company has given the port of New York dry docking facilities second to none in the world, and a distinctive advantage as pertains the maintenance of repair equipment to keep in commission a prosperous American merchant marine. It proves conclusively the claim of the Morse Company that large steamers can be lifted in from 20 minutes to a half hour.

When the sailing ship *Alejandrina* came to the Morse yards recently she occupied the big dry dock simultaneously with a modern steamship. But 19 feet of docking space remained unoccupied as repairers worked on the *Alejandrina* and the steamship sharing the same dock. This was a little less room than existed on another occasion when the United States Shipping Board steamer *Lake Fariston* and the S. S. *Yarmouth,* first steamship of the Black Star Line Corporation (composed entirely of American negroes), occupied the dock at the same time.

The massiveness of the dock is not altogether responsible for its sectional features. Built of six sections, two or more sections may hold a steamer while the remaining sections are submerged, ready to lift another ship. Repair work is thereby facilitated, and what was once a matter of hours and days is reduced to minutes.

First Electrically-Equipped Dock

As concerns its method of operation, the new dry dock is an exact duplicate of the older dry dock of the company, which was the first electrically-equipped dock in the world; the first on which centrifugal pumps were used for emptying it, and the first on which alternating current induction motors were used, and the first to be equipped with an auxiliary draining system. In many respects the older dry dock has been the most successful and efficient dry dock in the country, lifting in one year, it is claimed, three times the tonnage of any other dock in the same amount of time.

The *Minnesota* Was Lifted from the Water by the Morse Dry Dock in 25 Minutes' Pumping Time

A Sixty-Year-Old Floating Dry Dock

Durability of Wooden Floating Dry Dock Proved by Long Service on Gulf Coast—Lifting Capacity, 1,000 Tons

BY PAUL H. MACNEIL

THE age, construction and checkered career of the old "Bruce" dry dock, which is still in active and successful operation at Pensacola, Fla., should be of interest to all dry dock engineers, but especially to those who believe with the writer that though this may be rightly termed the "age of steel and concrete," both of these materials have yet to prove their superiority, in many respects, for floating dry dock construction, especially on the score of time-proven durability. The "Bruce" dock is but one of several old docks that have demonstrated the life of wooden construction for this purpose, but it is a worthy example.

800-Ton (Deadweight) Three-Master Docked in the Old "Bruce" Dock on November 14, 1917. Note Rock Ballast and Hand Pump Handles

This old pioneer floating dock was built of Florida pine at Bagdad, Fla., on the Blackwater river, in 1859-60 by Martin Bruce and William Ollinger, who had formed a partnership in 1858 to operate a small repair plant and marine railway at that port. They realized at once the advantage of a larger outfit and decided to build a floating dock. Having knowledge of a dock about the capacity that they desired, Mr. Bruce procured a set of the plans of this dock from a concern then in operation at Milwaukee, Wis. Whether or not he exactly duplicated the Milwaukee dock is not known, but it is presumed he did.

The dock was completed a short while before the outbreak of the Civil War, and upon hostilities starting the dock was sunk and the wings burned to the water to save it from possible destruction or confiscation by either the army or navy of the opposing forces. Thus it lay on the bottom of the Blackwater river for four years, when, the war being over, it was raised, repaired, the wings, or that portion which had been burned off, restored and the dock was once more put in commission. It is here worthy of note that, although the water at this port contains a sufficient amount of salt for the busy "teredo" to make a good living, the dock, when raised, had not been attacked by them during all of those four years.

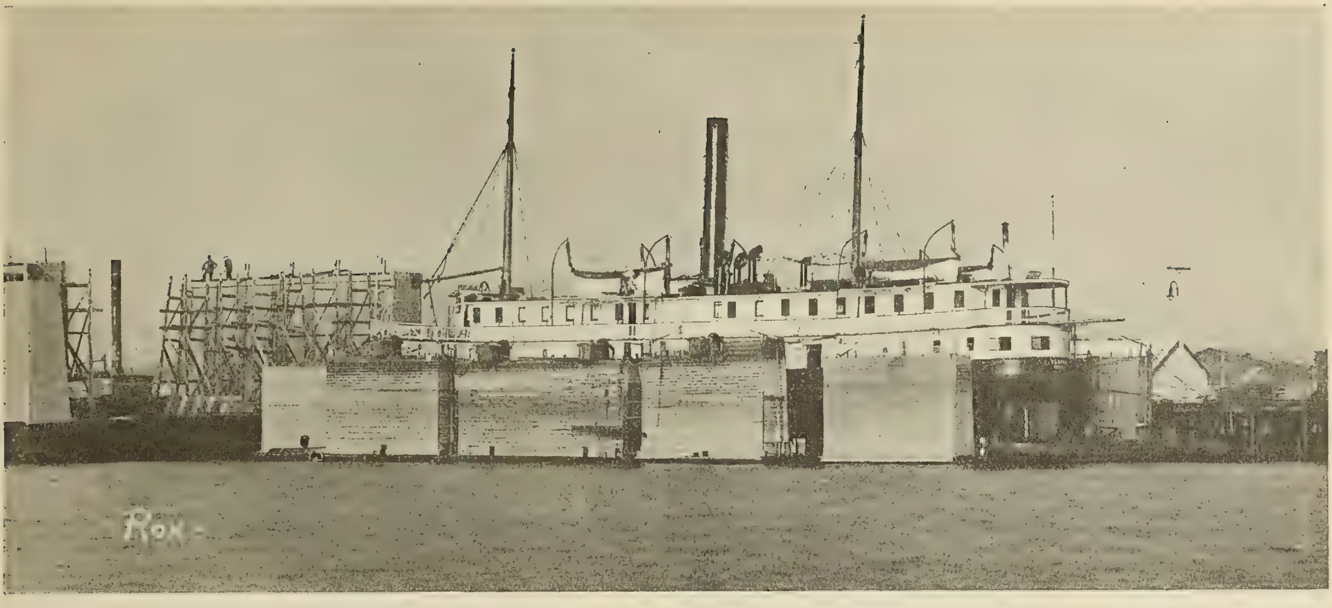
The dock was successfully operated for many years at the Bagdad plant—in fact, up until about twenty-five years ago, when Ollinger and Bruce started a new plant at Mobile, Ala., where they decided to build a new and larger dock. The old dock was left at Bagdad, where, unused and its active life apparently over, it finally went to rest again on the bottom of the river.

Abandoned and supposedly forgotten, the old dock was yet destined for still better days. After a second rest, submerged, of twelve years, W. A. Watson, then connected with the Ollinger and Bruce Company at Mobile, inspected the supposed-to-be wreck of the old Bruce dock, and, finding it in remarkably good condition and having extreme faith in its durability, raised the old veteran, and, in spite of the discouraging opinions of others, repaired and again put it in commission at the old Bagdad plant.

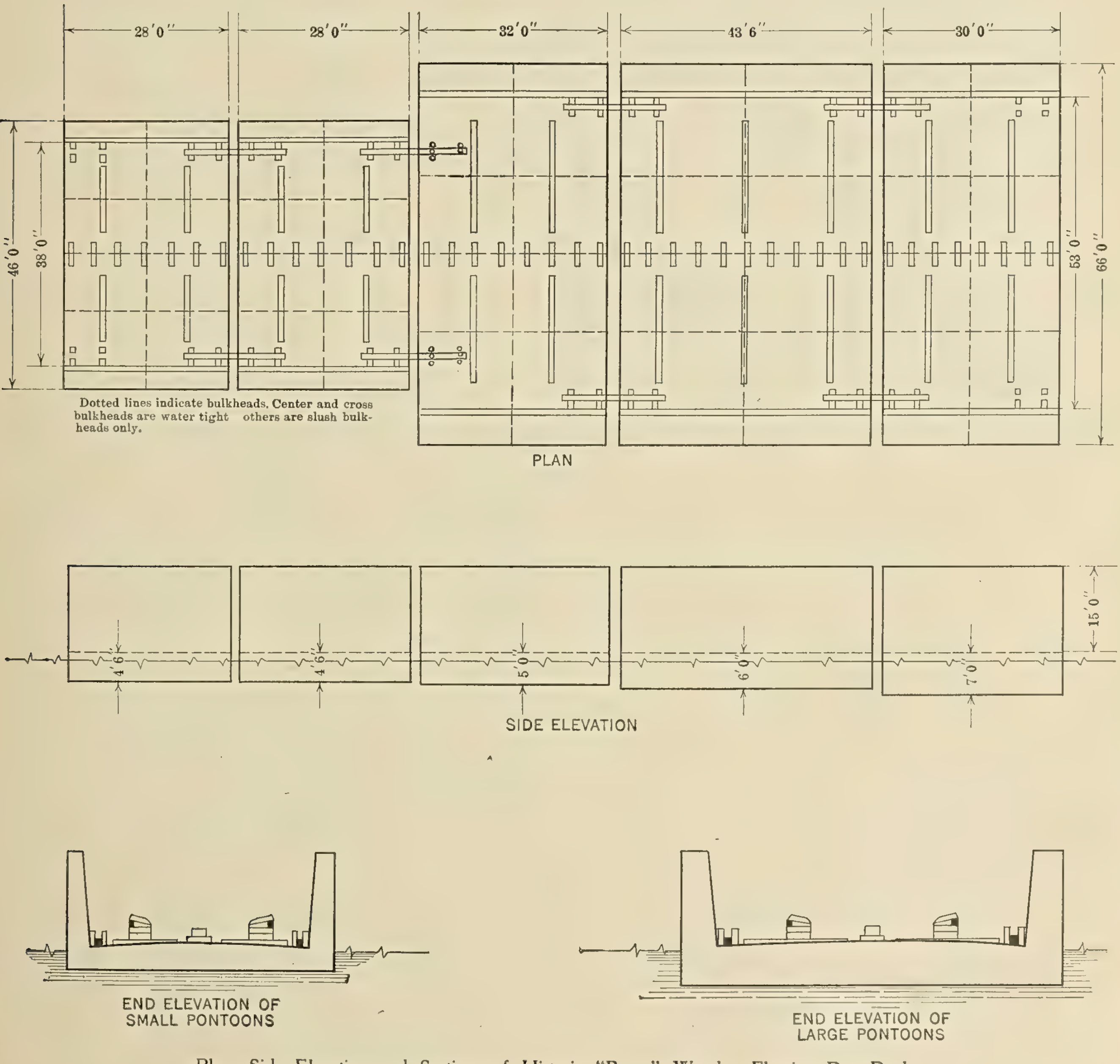
This happened in the spring of 1917. In the fall of the same year the Bruce Dry Dock Company, of Pensacola, Fla., was organized, and upon Mr. Watson becoming interested in that project he towed his Bagdad dock to its present salt-water berth in Pensacola Bay, where it now is at home and being continuously and successfully operated by this concern.

It will thus be seen that this old dock has passed three score years of a very checkered life. Twelve years beneath the waves, part of the time in fresh water, another in brackish water, and now in real salt water. It has now taken on an entirely new lease of life and, far from being water-logged, is lifting greater loads than it ever did before; this, of course, because of the difference in density of the fresh water where it was first operated and the salt water of its present home.

The dock was built when felt and creosote protection against teredo and other marine pests was unknown. It was built by energetic but inexperienced men in dry dock work or construction. Of course, during these many years, planking and calking have been renewed, but all of the original main framing is as sound today as it ever was and is good for as many years to come. The comparatively few but essential metal parts have had to be renewed many, many times in spite of the many kinds of paints and other protection that were tried.



600-Ton (Deadweight) Steamer Docked in Old "Bruce" Dock on January 1, 1920. Note Electric Pump Motors and Absence of Rock Ballast; Also One Pontoon of New 5,000-Ton Dock Under Construction in the Rear



Plan, Side Elevation and Sections of Historic "Bruce" Wooden Floating Dry Dock

The pumping equipment has now been modernized, the original hand pumps having been supplanted by steam syphons and electric pumps.

Since coming to Pensacola, felt and creosoted sheathing have been applied below the load waterline. Approximately one hundred tons of ballast, which had been previously used, was removed to add to the buoyancy of the dock, and it now has a maximum lifting capacity of a bit better than one thousand tons.

The dock is of five sections or pontoons, all interchangeable and self-docking and all of different dimensions, as will be noted on the accompanying plan. These pontoons are connected together with the old-time, familiar locking log. All calking was done with oakum.

From an operative standpoint, the dock is comparatively easy to handle, is economical in every way and with a maximum capacity load is as quickly raised as any of the modern floating docks of today. Is it to be wondered at that the present owners of this faithful old dock should be partisan to the *n*th degree towards wooden floating docks? And isn't it very logical for these people to adopt the same material throughout for the 5,000-ton dock they now have under construction to be operated alongside its older but smaller sister dock?

Absolute faith in the durability of wooden construction for this particular class of work, notwithstanding the many experts who believe otherwise, certainly seems justified by such an example as this, proven positive by the real test of time and not by theory.

A Method for Determining Diameter of Booms

BY C. A. VINCENT*

OWING to the great variations in methods of procedure and results obtained in the design of cargo and other booms, the author has endeavored, in the following article, to deduce an accurate formula that will be practical and give results compatible with general practice.

The problem will be taken up in two parts: first, to determine the thrust on the boom and, second, to determine the diameter.

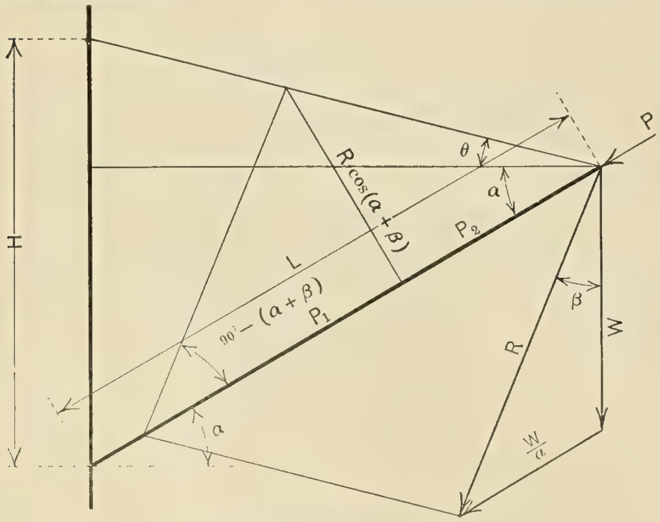


Fig. 1.—Diagram of Forces

Where

W = load.
R = resultant force.
P = axial thrust on the boom.
a = number of lines in hoisting tackle.
H = height of topping line at mast.
L = length of boom.
α = angle of inclination of boom.
β = angle of R with vertical.
θ = angle of topping line with horizontal.

Then, when the hoisting line is parallel to the boom,

$$(1) \qquad P = P_1 + P_2 = R \sin(\alpha + \beta) + \frac{R \cos(\alpha + \beta)}{\tan(\alpha + \theta)},$$

and

$$\cos \beta = \frac{W(a + \sin \alpha)}{aR}, \quad \sin \beta = \frac{W \cos \alpha}{aR} \text{ and } \tan \theta = \frac{H\text{-}L \sin \alpha}{L \cos \alpha}.$$

Whence expanding equation (1) and substituting:

$$P = R\left[\frac{W \sin \alpha\,(a + \sin \alpha)}{aR} + \frac{W \cos^2 \alpha}{aR}\right] + \frac{R\left[\frac{W \cos \alpha\,(a + \sin \alpha)}{aR} - \frac{W \sin \alpha \cos \alpha}{aR}\right]}{\dfrac{\dfrac{H\text{-}L \sin \alpha}{L \cos \alpha} + \tan \alpha}{1 - \dfrac{(H\text{-}L \sin \alpha)\tan \alpha}{L \cos \alpha}}}.$$

Which readily reduces to

$$(2) \qquad P = \frac{W}{a}\left(1 + \frac{aL}{H}\right).$$

And in a similar manner, if the hoisting line is very near and parallel to the topping line, equation (1) still holds; but

$$\sin \beta = \frac{WL \cos \alpha}{aR\sqrt{H^2 - 2HL \sin \alpha + L^2}},$$

$$\cos \beta = \frac{W}{R} - \frac{W(H\text{-}L \sin \alpha)}{aR\sqrt{H^2 - 2HL \sin \alpha + L^2}},$$

$$\tan \theta = \frac{H\text{-}L \sin \alpha}{L \cos \alpha}.$$

Then expanding and substituting in equation (1) and reducing,

$$(3) \qquad P = \frac{WL}{H},$$

which shows that the value of P is independent of the angle of inclination; i. e., P is constant for all values of α.

Now, taking up the second part of the problem, to determine the diameter of a solid round boom to safely withstand the thrust P.

If an attempt is made to solve the combined formula

$$f = \frac{P}{A} \pm \frac{Mc}{I - (Pl^2 \div KE)}$$

for the diameter, an insolvable equation of the sixth degree results and a solution must be obtained from another source. Let

D = diameter of the boom at mid-length.
f = total unit allowable stress.
K = ratio = $\dfrac{\text{unit allowable stress for column}}{\text{unit allowable stress}}$.
w = unit weight of material.
f_b = unit stress due to bending.
f_p = unit increased stress due to thrust.
M = bending moment of a cylinder of diameter D.
JM = equivalent bending moment of boom diameter D at center.
A = area of section.
S = section modulus.
L, P and α = same as above.

* With G. M. Standifer Construction Corporation, Vancouver, Wash.

Then

$$f = f_b + f_p,$$

$$f_b = \frac{JM}{S} = \frac{JwL^2 \cos\alpha}{D},$$

$$f_p = \frac{P}{AK} = \frac{4P}{\pi KD^2}.$$

Whence

$$f = \frac{JwL^2 \cos\alpha}{D} + \frac{4P}{\pi KD^2};$$

or

$$\pi KfD^2 - Jw\pi KL^2 D \cos\alpha - 4P = O.$$

As K contains the element $\frac{L}{D}$, it will be necessary to substitute its value in order to solve for D. This value varies considerably with different authorities, but Johnson's straight line formula is most generally used because

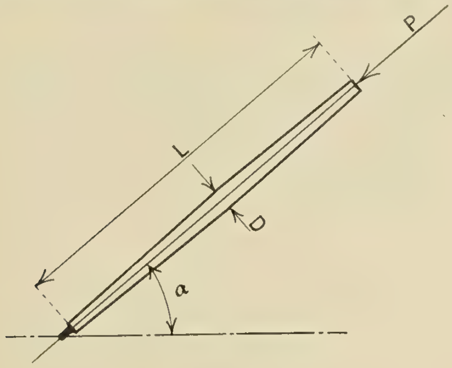


Fig. 2

of its simplicity and the fact that the results obtained agree closely with actual tests.

Then for wooden booms with round ends,

$$K = \left(1 - \frac{L}{53D}\right),$$

which gives a line tangent to Euler's curve at $\frac{L}{D} = 35$, which is near the mean ratio for booms.

When substituting,

$$\pi fD^2 - \frac{\pi LfD}{53} - Jw\pi L^2 D \cos\alpha + \frac{Jw\pi L^3 \cos\alpha}{53} - 4P = O$$

Or

$$\frac{\pi}{4} fD^2 - \left(.01482 fL + \frac{\pi}{4} JwL^2 \cos\alpha\right) D + .01482\, JwL^3 \cos\alpha - P = O$$

and

$$D = \frac{.01482 fL + .25\pi JwL^2 \cos\alpha \pm \sqrt{(.01482 fL - .25\pi JwL^2 \cos\alpha)^2 + \pi fP}}{.5\pi f}$$

By inspection it is evident that the condition of loading causing the maximum stress in the boom is when $\alpha = O$, i. e., $\cos\alpha = 1$; and for booms with diameter at ends equal to $0.75D$, $J = 0.9$.

Whence

$$D = \frac{.01482 fL + .70686\, wL^2 \pm \sqrt{(.01482 fL - .70686\, wL^2)^2 + \pi fP}}{1.5708 f}$$

Taking into consideration impact and the dry, well-painted condition of ships' booms, for Douglas fir $f = 750$ pounds per square inch and $w = 0.0197$ pounds per cubic inch. Then

$$D = \frac{11L + .014L^2 \pm \sqrt{(11L - .014L^2)^2 + 2356P}}{1178}$$

nearly, where L and D are in inches and P in pounds. For steel booms the method of deduction is analogous.

Assuming the inside diameter of the boom at mid-length as

$$0.95D, \text{ and } K = \left(1 - \frac{L}{64D}\right) \text{ and } J = 0.95.$$

Then

$$f = \frac{.49932\, wL^2 \cos\alpha}{D} + \frac{P}{.07658 D^2 - .0012 LD}$$

and

$$D = \frac{.0012 fL + .03824\, wL^2 \cos\alpha \pm \sqrt{(.0012 fL - .03824\, wL^2 \cos\alpha)^2 + .3063 fP}}{.15315 f}$$

Taking $\cos\alpha = 1$, $f = 13{,}125$ pounds per square inch and $w = 0.283$ pound per cubic inch. Then

$$D = \frac{15.7L + .011L^2 \pm \sqrt{(15.7L - .011L^2)^2 + 4020P}}{2010},$$

nearly.

SUMMARY

When the hoisting line is parallel to the boom,

$$P = \frac{W}{a}\left(1 + \frac{aL}{H}\right)$$

And when the hoisting line is near and parallel to the topping line,

$$P = \frac{WL}{H}$$

Where P = axial thrust on the boom, W = load, a = number of lines in the hoist, L = length of boom, and H = height of topping line at mast.

For round wooden booms,

$$D = \frac{11L + .014L^2 \pm \sqrt{(11L - .014L^2)^2 + 2356P}}{1178}$$

And for hollow steel booms with an inside diameter equal to $0.95D$,

$$D = \frac{15.7L + .011L^2 \pm \sqrt{(15.7L - .011L^2)^2 + 4020P}}{2010}$$

Where D = diameter inches and L is in inches and P is in pounds.

It is very amusing to watch a man tip the long slim bottles that the oil salesman has and watch his wise expression as the bubble runs to the top. The oil man smiles to himself and clinches the order when he says, "You know something about oils, I see." Flattery is very much like oil, it smooths things in our lives.

If you had four or five old-fashioned razors, would you open them and toss them into a drawer? Of course not. Why, then, chuck your files into a drawer with a lot of junk. The files have keen cutting edges just as razors do, so just think this over and use some sense with files. They cost money these days.

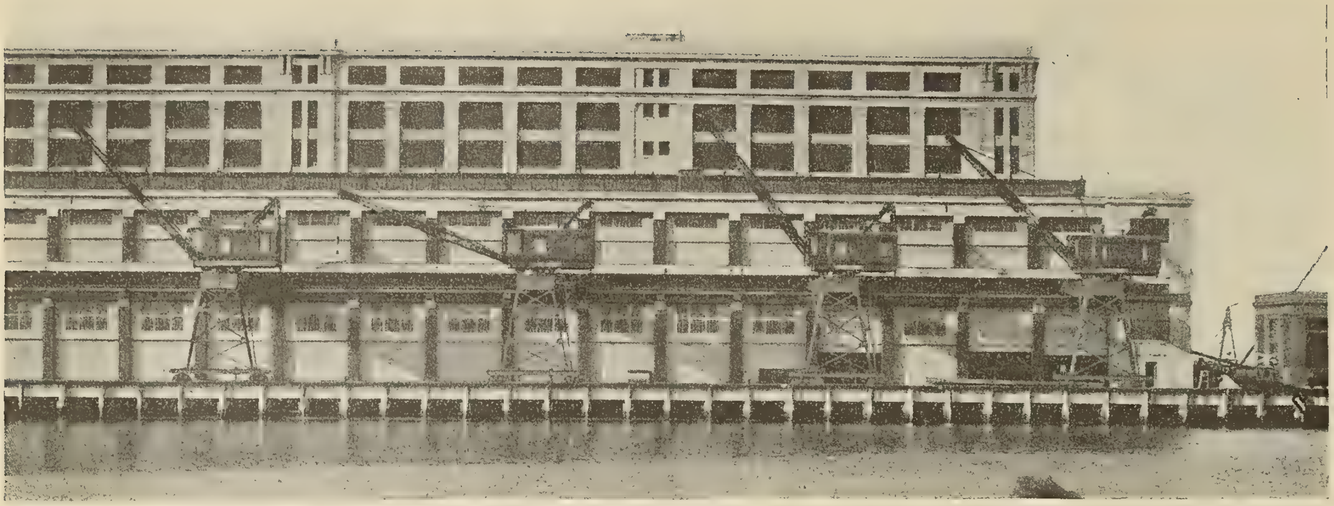


Fig 1.—Quay Terminal Equipped with Half-Arch Traveling Gantry Jib Cranes

Quay Design for Ocean, Lake, Inland River and Canal Terminals

BY H. MCL. HARDING*

It is the purpose of this paper to generalize and codify dimensions derived from a large number of quay terminals, so that it may be possible for an engineer to plan quay terminals at which there will be attained the greatest possible speed in transferring and handling freight.

IN comparison with piers, quays are more economical to construct. They allow more rapid freight movements and afford better and more rapid railway coordination.

Where the physical conditions are favorable and there is ample length of water frontage, quay construction is preferable.

Advantages of Quay Construction

Along a narrow river there is generally not sufficient water area for the piers to project into the waterway even at oblique angles, and in this case quays or slips are unavoidable. Slips dredged into the land are not advisable, if the shores are high, rocky or the land is valuable. It is a terminal principle with certain exceptions that the land area, especially in front of a city, should be conserved. This seems a self-evident truth, but the principle is often ignored.

It often happens, due to financial or other considerations, that a quay terminal should at first be installed, with provision for piers to be added later, when there is a demand for more berthing facilities.

Future Piers

Where piers are to be later installed, the quay design varies somewhat as to the shed, warehouse and railway positions. There are many locations, especially along inland rivers and narrow estuaries, where only the quay design is feasible.

It sometimes happens, however, where there are large and low waterfront land areas, that slips are excavated a considerable distance into the land with a wide land area between the two slips or a wide and long area is filled and projected into a large shallow bay. In these two cases the design is rather that of the quay than of the pier type, although the plan would seem to be of a broader pier.

Terminal Features

A terminal plan with a quay design comprises many elements, which are not merely the berthing frontages but the sheds, warehouses, railway tracks, mechanical appliances and numerous other facilities, many due to special industries, all of which pertain to securing the utmost speed in all the terminal freight movements. These elements must be so proportioned to each other that all can be operated freely without friction and at a continual speed and also having a sufficient placing or holding capacity so that there will not be the too often delay-producing congestion—that is, all open areas and cubical contents of buildings should be such that each will have but little excess over the demands that may be made upon them.

Correct Proportioning of Terminal Elements

The terminal should not be overshedded, not have too much distance between the face of the quay wall and the shed, nor too much vacant space along the waterfront.

As far as possible, the quay wall should be in a straight line divided into units. Any variations from the straight line, if necessary, should be at the end of a unit. The length of each unit should be equal to the length of the longest ship which may be expected to berth there, giving due consideration to future increases in lengths of ships.

The following lengths of units may serve as a general guide, but these dimensions, as well as others given in this paper, are subject to exceptions depending upon

* Consulting engineer, Harbor Commission, city of Milwaukee, Wis.

local conditions and limitations. It is wise not to base one judgment or form general conclusions from a knowledge of one port, but study many ports of different countries.

Lengths of Quay Units

For inland rivers having a navigable depth of not more than 12 to 15 feet, where only barges will use the units, the length of each unit may be from 300 feet to 350 feet. On inland rivers of a depth of water of 25 feet to 30 feet the length of each unit may be approximately 500 feet, and along the seaboard and Great Lakes terminals the length should be from 600 feet to 700 feet. These unit lengths are for freight terminals. For passenger terminals or combined passenger and freight terminals these figures would often be varied.

As the frontage of a quay is usually straight, and as there are a number of continuous units, a ship can then readily berth even though longer than any one unit. Ships of various lengths can be accommodated along the quays without there being linear frontage unoccupied. The unit division is of advantage in financing the terminal and in providing sheds, warehouses and other facilities to the rear of each unit frontage proportioned to each other. If in pier construction the pier be 600 feet long and there be two ships each 450 feet in length, only one ship can be berthed along one side of the pier and 150 feet would be unoccupied. If one ship be on each side of the pier, then there would be 300 feet idle.

It is evident that with a straight quay, as formerly at Antwerp, there is often a continuous line of ships about six miles in length with scarcely a vacant space.

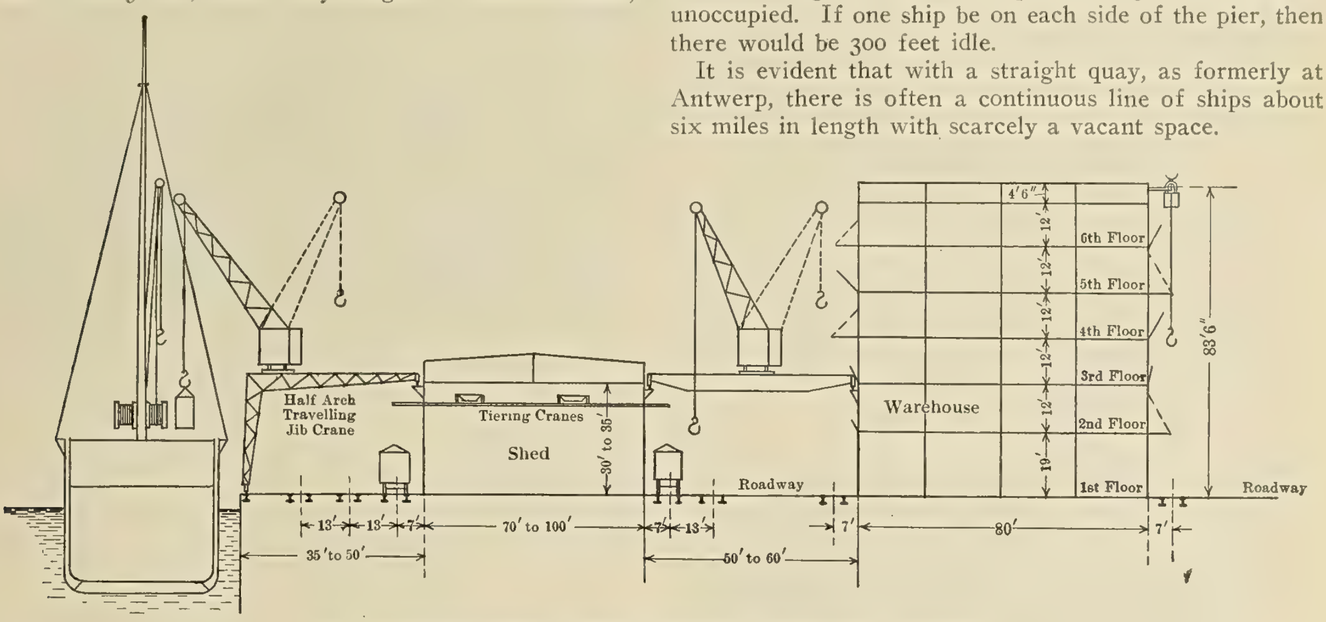


Fig. 2.—Diagram Showing Section Through Typical Quay Terminal

Quay Areas

For the purpose of an illustration, it is assumed that the quay unit will be 600 feet in length and that the width of this unit at right angles to the quay designed for efficient operation will be from 250 to 300 feet. There are other elements of a terminal which are common to all the units or to the whole terminal, as storage railway tracks, drayways and terminal manufacturing lofts.

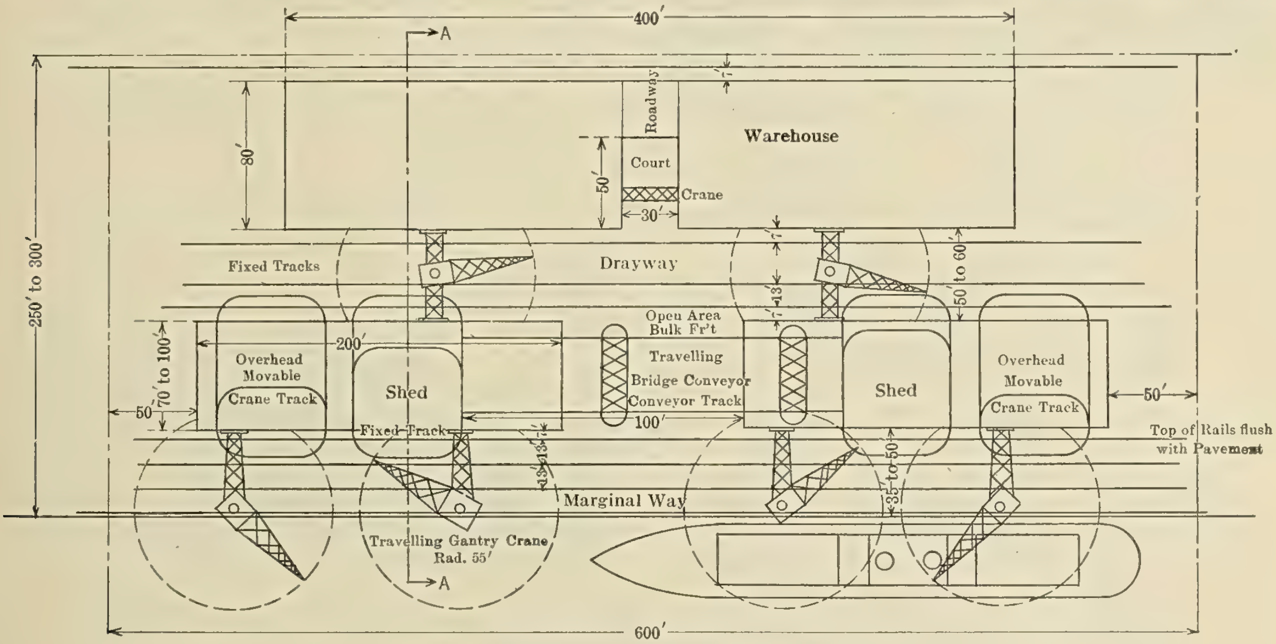


Fig. 3.—Plan of Typical Quay Terminal

Division of a Unit Length

A unit length of 600 feet should be divided as follows: Fifty feet open area at the end of this unit and fifty feet

open area on the adjoining unit would leave here a continuous open space of 100 feet long and 250 to 300 feet wide. Next there would be a shed, preferably of one story, 200 feet in length and from 60 to 100 feet in width and 30 to 35 feet clear height beneath the roof trusses. Beyond the end of this shed there is another open intervening space between this shed and the next, of 100 feet in length, then a similar shed and then another open space of 50 feet. In adding the lengths of one unit together there will be 50 + 200 + 100 + 200 + 50 = 600 feet, the length of the unit.

Quay Shed Dimensions

In older designs the shed was from 400 feet to 500 feet or of a more continuous length, and there are advantages from this design. It was found, however, in many cargoes that there was a certain amount of inbound coarse and bulk freight that was not affected by the weather, some of which, as lumber and structural steel, was difficult to transfer into the shed and there to handle readily, that is, to distribute, assort and tier.

There was also freight for which there was no necessity

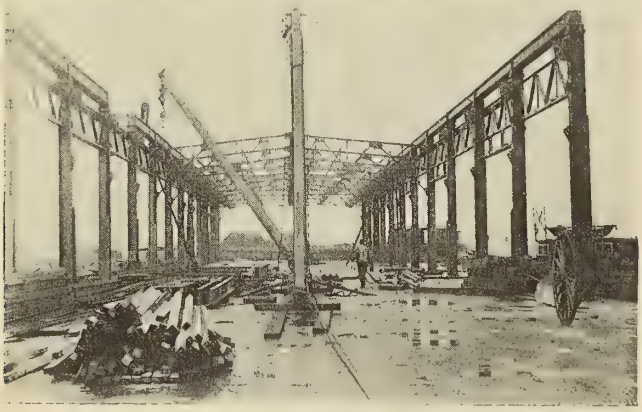


Fig. 4.—Details of Construction of Terminal Shed, Indicating One Method of Attaching Crane Rails, Steel Framing and Roof Trusses

for shed storage, and the fire risk on it was high, as, for example, asphalt in barrels.

Open Storage Area

By having the total open storage areas 200 feet long parallel to the quay wall and 300 feet wide at right angles to the quay, with a total area of 600 square feet gross, or about 30,000 square feet net, greater speed of freight movements could be attained and at a less cost than if all commodities were placed within the shed. There is also afforded more direct access from the waterfront to the rear than where the unit shed is of one continuous length.

The width of this unit is, according to the best practice, apportioned as follows:

Division of Unit Width

The first 35 feet to 50 feet directly to the rear of the face of the quay wall is reserved for railway tracks. It is not advisable to have this distance more than 50 feet, and no freight is to be stored in this area between the edge of the quay and the shed. It is for railway tracks and drayways.

The distance between the edge of the quay and the front of the shed is generally of such length that it can be served by not more than a quarter revolution of the gantry crane jib from this edge of the shed.

There is so little difference in length between the quarter circle and the chord of this jib that the path of the crane-load is for practical purposes a straight line, without the necessity of having congestion at the place of deposition as when there is only a straight-line track.

Railway Tracks and Co-ordination

Where there is ample room there should be three tracks, the outside tracks for loading and unloading and the cen-

Fig. 5.—Southerly and Easterly Side of Quay Shed. In Front, a Small Portion of the Southerly End Is Partitioned Off for Offices

ter track for a switching track with cross-over switches at about every 100 feet.

These tracks should extend along the whole quay frontage with track connections to the rear tracks.

Railway Track Location

These front tracks, located between the shed and the quay wall, are chiefly for outbound freight, which often may be transferred from open cars or from the doors of box cars directly into the hold of the vessel.

This freight movement is chiefly from cars on the track nearest the edge of the quay, but the transference may be from any of the three tracks.

Should there not be any ship ready, the freight, if a ship is soon to be berthed there, is transferred from the tracks into the shed, and when the ship arrives from the side of the shed nearest the quay or from the overhead carriers the freight is burtoned and swung by the gantry cranes into the ship.

Shed and Warehouse Functions

If the outbound freight is to be held for more than seventy-two hours awaiting a full cargo, it should not go

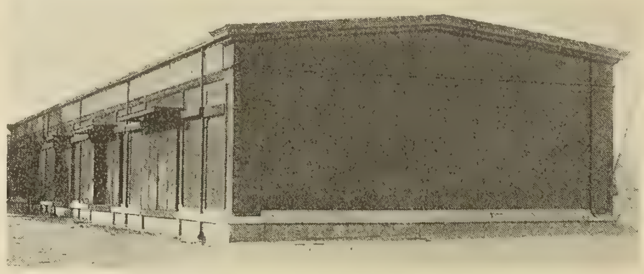


Fig. 6.—North and Shore Side of a Small Steel Shed. The Frame Is of Structural Steel with Galvanized and Painted Sides and Ends. In Front, the Floor of the Shed Is Flush with Pavement. The Foundation Is of Concrete

into the shed, but be placed in the warehouse until the ship is ready to receive it.

These frontage tracks are spaced 13 feet centers, the center of the first track being about 7 feet from the front of the shed.

Behind this front track space of the unit are the two tandem sheds, of steel construction, each being of the following dimensions:

$(200 \times 80 \times 35) \times 2 = 1{,}140{,}000$ cubic feet.

The shed may be 100 feet in width.

The available cubical content of the largest ship there berthing, deducting space for machinery, ship stores and quarters, would not exceed from 500,000 to 600,000 cubic feet.

Freight Allocation

Part of this can probably be stored in the three open areas, possibly approximately 20 percent, which would leave only 420,000 cubic feet for the shed. Part of the freight may be unloaded directly upon lighters and part immediately upon the waiting railway cars and dray trailers. All freight should be moved from the shed within seventy-two hours as the maximum time of holding. Sheds are not to be regarded as storage warehouses any more than should railway cars. They are equivalent to an unloading platform. Long-storage warehouses will be provided where freight may remain as long as the storage rates are paid.

The waterfront of any terminal is necessarily of most value and is limited. The number of sheds between which and the ships there can be direct transference is therefore limited.

Many warehouses can be located to the rear of the sheds, in which freight may be held for months or years. Between these warehouses and the ships there is nothing like the number of movements that there are between the sheds and the ships. The warehouses may be placed to the rear of the sheds and some at a considerable distance if necessary. One row, however, should be located directly to the rear of the shed.

Freight Movements

In designing and planning the location of terminal works and facilities, there must be an exact knowledge of the terminal freight movements, as well as experience with the usual operating conditions. To the rear of the shed there should be a space of fifty feet between the shed and its supporting warehouse. Within this area there should be railway tracks spaced as shown on the accompanying plan. There is also a drayway and a dray area for the empty and full drays corresponding to the railway storage tracks for the railway cars.

The tops of all the rails should be flush with the pavement, so that they may be readily crossed by drays.

The Warehouse

The warehouse, 400 feet long and 80 to 100 feet wide, is in effect two warehouses joined together above the ground story, but with a court 30 feet in width separating the two wings in front. Above the first story they are connected by floors 60 feet in width. There is a passageway between the front and the rear of the warehouse through the court on the ground floor.

The lower story of the warehouse is 18 feet in height, so that railway cars can pass into and through the lower story. The upper stories are 12 feet 6 inches in height.

These warehouses are of reinforced concrete.

Behind the line of the warehouses are three more service railway tracks with the top of the rails flush with the pavement.

There may be other warehouses to the rear with storage tracks between.

The Freight Shed

Although the freight shed should be of one story, it is equivalent in height and in holding capacity to a shed of more than two stories. In fact, it may be regarded as a two-story shed with the floors and supporting girders of the second story omitted.

Such a one-story shed, equipped with overhead mechanical tiering and distributing facilities, will have at least thirty percent more workable and holding cubical space than a two-story shed with the usual fifteen feet between the floors and with supporting girders or trusses. Not only is no space lost by having the high studded one-story shed, but there is great gain in operating space. The cost of the two-story shed is more than double that of the one-story shed. The shed is for temporary holding of the cargoes not to exceed a holding of more than seventy-two hours.

Probably, on the average, including the outbound and inbound freight, seventy percent is through freight. Of this through freight forty percent may be held in the warehouse waiting for cars to transport by land to the interior of the country or for other ships to transport by water to other points. These quick movements influence the design of the shed as to size.

The function of the steel shed is not for long storage,

Fig. 7.—Half-Arch Traveling Gantry Crane

and this fact cannot be too strongly emphasized. Its development is closely connected with the history of quay terminals.

History of Shed Development

In the beginning there was only the open wharf without any building as a protection against inclement weather. A tarpaulin or a canvas drawn over the goods was the only protection against the rain. These goods were removed from the wharf as soon as possible. Later there was a roof of canvas and then of a more permanent material. One side was at first closed in and finally it became a building with roof, sides and doors.

Up to this time it was recognized that the shed was only a temporary location for the inbound cargoes until such time that the freight could be transferred to the store or to the private warehouse of the consignee or to land carriers or other water carriers for further transportation.

The outbound freight was sent from the factory, store or warehouse and placed upon the quay as soon as the ship was ready for its cargo. Outbound freight from the interior was generally consigned to a private storehouse or held in or on railway cars awaiting the arrival of the ship.

After a while, as traffic increased, the shippers and consignees, with competing lines as the argument for storage favors, began using the shed as a warehouse in the same way they had been using the cars. Even though there was a high storage charge, it was cheaper than the handling and carting to remote storage buildings. The sheds being used as warehouses soon became congested and additional quay berths with sheds were continually being constructed.

Next came the warehouse, built upon the terminal area and under the control of the terminal authorities, in close proximity to the shed, so that the movement between the buildings could be performed mechanically at the least expense. This expense of moving was charged to the shipper or consignee.

These warehouses, generally of concrete, were of six stories and even more up to twelve stories, often double the length of the sheds and wider. Not only was there one warehouse behind the line of sheds, but there were many parallel rows of these towering buildings.

When the commerce of the port becomes sufficiently large, there will be warehouses for the different commodities, that is, separate warehouses for tobacco, sugar, cotton and other products.

The most important feature of the terminal is the securing of speed, that is, a rapid, continual succession of movements of the freight between the water or land carriers and the place of deposition. Any influence which produces congestion causes delay and prevents the all-important speed of freight movements from being attained.

Shed Function

As already stated, the function of the shed is to have a covered and enclosed area where the inbound freight can be assorted, distributed and tiered and held for twenty-four, forty-eight or seventy-two hours. If not removed within the official time of holding, it is mechanically transferred to the warehouse.

The outbound freight, when possible, is swung from the railway cars into the hold of the ship, or if the ship is not already berthed but soon expected the freight may be placed in the shed, if there is room. If there is a possibility of the ship being delayed or in the receiving this outbound freight, then the freight should be sent into the warehouse and from the warehouse transferred directly into the ship when the ship is ready.

Outbound freight is often held in the warehouse until a full cargo for the ship is collected. In any event, the temporary holding shed should not perform the function of the long storage warehouse.

Shed Design

The design of the shed should be such as to cause no interference with rapid freight movements. The floor space should be as free as possible from obstructions of every kind. A comparison between the operation of two sheds, one having columns and the other having a clear space without columns proved conclusively that the presence of columns was disadvantageous to the quick movements of the freight handling. As much floor area as possible should be kept for its legitimate purpose of working area and for temporary holding of inbound freight. Elevators, chutes and stairways occupy or prevent the area space from being fully utilized.

The relative locations of the quay, the railway tracks, the sheds and the warehouse are shown on the plan accompanying this paper.

Mechanical Appliances

The only possible way known to obtain a greater speed of transference and handling is by the installation of machinery. This means to adopt such standard machinery as has enabled speed to be attained at many marine terminals of foreign ports.

This does not signify a slavish copying, but the adoption of such machinery with improvement adapted to American conditions.

Traveling Gantry Jib Cranes

As the best results of loading and discharging the ships are obtained by a combination of ships' winches and gantry cranes, the correct design and the location of these cranes relative to the sheds are essential to obtaining speed.

Where the conditions will permit, the traveling half arch, gantry jib crane is preferable, as the obstruction by the rear legs is eliminated. Where half arch is not possible, the full arch should be installed.

The jib should extend fifty feet beyond the edge of the quay, and about fifty feet above the quay wall. The distance between the front and rear rails should be between 35 feet and 50 feet, and the clear height below the horizontal member of the crane from 18 feet to 24 feet, depending upon the laws of the different states.

The speed of hoisting should be from 200 feet to 300 feet per minute, the speed of revolving two or three revolutions per minute, and the speed of traveling along the quay from 200 feet to 300 feet per minute.

There should be a separate motor for each of the three movements of hoisting, revolving and traveling. In general, these miscellaneous cargo cranes only have the three movements. Should the cranes have the derricking movement in addition, there should be a fourth motor for this movement.

Crane Capacity

The type of gantry jib crane best adapted to the discharging and loading of miscellaneous cargoes may be designed as the 2- to 4-ton crane.

Such a crane with one rope has a lifting capacity of two tons with a hoisting speed of 200 feet to 300 feet per minute and the same crane has a capacity of four tons at one-half the above hoisting speed. This 4-ton capacity is provided so that the clamshell or grab buckets may be operated when desired.

The above cranes have a temporary excess capacity of fifty percent.

At a public terminal it is known in advance that freight of every kind and description will be transferred and handled and any machinery must be universal in its character.

These cranes should be of a rugged type, or low first cost, so that it may be possible to install a sufficient number to secure the utmost speed in loading and discharging. At Hamburg there is a crane for every 62½ feet.

Number of Cranes

To obtain the best results there should be two cranes operating at each hatch of the ship. There should be one slow-speed stationary jib crane of a capacity of about 25 tons, located where it will not interfere with the travel of the gantry cranes. Provision should be made for the attachment of an electric motor in the future.

Shear legs would sometimes be of great service to the port and may be installed.

Operation

In loading, the gantry jib crane swings the load by an almost straight line and lowers into the ship hold.

In discharging, where there are winches on the ship, these winches can draw from between decks to above the upper deck and the draft is then burtoned to the hook of

the gantry crane, which swings to the place of deposition. By this combination of the ships' winches and the gantry cranes the best speed known is obtained. Instances have occurred where four to six drafts are moving simultaneously at one hatch and at five hatchways there may be from twenty to thirty drafts.

To assort, distribute and tier this great volume of freight properly there is required some kind of overhead machinery to relieve the floor of possible congestion. A modification of the overhead traveling crane, but with a lateral travel of a number of grabs, instead of only one travel between the sides, well fulfills the exacting conditions of these freight movements and serves every square foot of the floor area and every cubic foot of space.

There should be as many direct paths as are necessary, whereby the freight can be lifted from the floor of the shed and delivered to the gantry cranes for lowering into the hold of the vessel. The mechanical lifting is of equal importance with the mechanical conveying. It should also be commercially practicable to serve equally well by the same machinery cars in the rear of the shed as well as those in front. The plans accompanying this paper explain the general arrangement of the terminal.

That there may be no delay in the moving of the freight held in the shed beyond the specified time, between the shed and the warehouse, cranes as shown in the design are provided. There is not the same necessity for machinery within the warehouses as in the sheds, as freight, especially in the upper stories of the warehouses, may not be moved for months. There should, however, be provided machinery for quick elevating and lowering, chiefly large elevators within the building and whips outside.

CONCLUSIONS

First.—That the most important feature in quay terminal design is the securing the utmost speed in all cargo and freight movements.

Second.—In order that this result may be attained, all the terminal elements should be relatively proportioned to each other so as to eliminate the possibility of congestion points.

Third.—That the only way to improve existing conditions is to utilize standard mechanical appliances which are in successful commercial operation.

Diesel Engine Construction in Europe

BY OUR SPECIAL LONDON CORRESPONDENT

Although in the early stages of Diesel engine development British shipbuilders and marine engineers adopted a very conservative attitude towards the motorships, they are now apparently all so thoroughly convinced there is a great future for the internal combustion-engined vessel that large sums of money are being expended in equipping their works for oil motor construction and experimental work. It is the current belief in Great Britain that the day of the motor passenger liner of 20,000 to 24,000 horsepower is not far distant.

AS an instance of the thoroughness with which some firms have gone into the question, it may be mentioned that Doxfords, whose output of merchant ships last year was equal to that of any English shipbuilders, have spent $487,000 (£100,000) in new equipment and experiments, although they have not yet built a single motorship. Yet they are far-sighted enough to believe that this is the best investment they have made, for they have developed an oil engine with which they are so thoroughly satisfied that they are standardizing it for cargo ship propulsion and are now building two sets of the standard type (3,000-horsepower, 4-cylinder engines) to be installed in vessels of 10,600 tons deadweight capacity, which they will probably operate themselves.

LARGE PASSENGER MOTORSHIPS COMING

Similarly, Harland and Wolff have equipped magnificent shops at Glasgow solely to build oil engines up to 6,000 horsepower. Armstrongs, Vickers and Beardmores have done the same on a slightly smaller scale, while the North British Diesel Engine Works at Glasgow has been laid out at a huge cost, with a plant designed to build marine Diesel motors up to 12,000 horsepower. For it is the current belief in Great Britain that the day of the motor passenger liner with engines of 20,000 to 24,000 horsepower is not far distant. Indeed, plans have already been prepared for such vessels, and as Lord Pirrie is connected with the project it is not likely to die of inanition.

The Johnson Line of Stockholm has just added another motorship to the nine which it already possesses; and as it is now building oil-engined vessels to the exclusion of steamers, this gives a good indication of the relative value of the two classes of craft—at any rate for the trade upon which the Johnson Line is engaged.

The new vessel, which is due to start immediately on her maiden voyage from Stockholm to America, is the *Buenos Aires* and may almost be termed a stock boat, so many exactly similar craft having been built. She carries 9,400 tons deadweight and is equipped with two 1,550 indicated horsepower, 4-cycle Diesel engines constructed under license from Burmeister and Wain by the Gothenburg Shipbuilding Company, of Gothenburg, Sweden, where the *Buenos Aires* was built.

EARLY BURMEISTER AND WAIN DESIGN STILL FOLLOWED

It is a remarkable fact that these engines, excepting in minor details, differ only slightly from the first Burmeister and Wain sets which were installed in the pioneer motorship *Selandia* in 1911. The chief difference lies in the air compressor arrangements for the injection air, since in the latest type a self-contained vertical three-stage compressor is fitted on each engine, whereas in the early machines only the high-pressure stage was operated from the main engine and the low- and the intermediate-pressure cylinders were entirely separate, driven either by an electric motor or by a high-speed Diesel engine.

Another modification in design, which is to be noticed in the latest Scandinavian motorships, is instanced in the *Afrika*, the world's largest motor vessel which is now nearly completed for the East Asiatic Company. This

concerns the engine room auxiliaries more than the propelling plant. All deck winches (of which there are 20), the anchor windlass, steering gear, refrigerating plant and pumps are electrically driven (this is the modern European practice), and the power is supplied from no fewer than four Diesel-driven, 220-volt generators in the engine room. Hitherto two, or at most three, sets were installed, but there are various advantages in providing four of relatively small power. In the first place they are identical in every respect, so that the number of spare parts required is reduced, while it allows of great convenience in operation. At sea, two sets are easily sufficient for the work, while in port, when all the winches are working, three generating plants will take the load, still allowing one as standby. Again, when in port, with the ship lying idle, when electricity is only required for lighting and one or two odd pumps, a single set will do all that is needed. Each of these generating sets is of 60 kilowatts driven by a two-cylinder, high-speed Diesel engine, a neat self-contained plant, which, by being thus standardized, can be, and is being, turned out in dozens by the manufacturers at relatively low cost.

Four-Cycle vs. Two-Cycle Engines

Much controversy has been aroused recently in Great Britain over the question of the most suitable type of Diesel engine for marine work, and it is proof of the lack of unanimity which exists to mention that of the six leading builders in the country—Vickers, Harland and Wolff, North British Diesel Engine Works, Armstrongs, Doxford and Cammell Lairds—the three former have wholly pinned their faith in the four-cycle motors, while the three latter are relying with equal determination on the two-cycle, single-acting type. One thing appears quite certain: that the valve-scavenging, two-cycle motor, such as was built at the Navy Yard at New York some years ago for installation in the *Maumee,* is quite dead so far as British engineers are concerned. The danger of cylinder cracks is considered to be too great for practical utility at sea, and the ill-success of the Krupp-engined, American-owned *Glenpool* (ex-*Hagen*) certainly gives some ground for this belief. It is understood that the 3,900-horsepower engine being built by the Bethlehem Shipbuilding Corporation is to have valve scavenging, but it is possible that this is incorrect.

It is curious that the opposed piston, two-cycle engine has not been taken up in America, for both Doxfords and Cammell Lairds are building to this design; but there is reason to believe that a well-known American firm will shortly construct the Cammell Laird engine under license. In England a good deal of faith is placed in the opposed piston type, as it is very suitable for low propeller speeds, and the 3,000-horsepower Doxford engines mentioned above have a maximum speed of 77 revolutions per minute, which is just what is required for the average 10,000- to 14,000-ton cargo ship.

Welding an Engine Cylinder from the Inside

Twenty-Five Patches Welded on Interior of Cylinder By Electricity Without Distorting Bore of Cylinder—Notable Example of Cast Iron Welding

BY OTIS ALLEN KENYON

It is believed by many that welding on the inside of an engine cylinder on the working surface is an operation fraught with danger to the engine. First there is the difficulty of welding cast iron and then there is the danger of distorting the bore of the cylinder by the heat. In fact, the job here described was turned down by several professional welders before it was finally brought to the Electric Welding Company of America, Brooklyn, N. Y., which did the job.

This company, which has been in the welding business for over ten years, makes a specialty of cast iron work, and the mere fact that it has done this class of work on a commercial basis for many years goes to prove a contention that is often made by the writer, namely, that it is the welder and not the machine that determines the success of cast iron welding.

In cast iron welding there are three things that must be guarded against, if success is to be had, namely:

1. Layer of hard and brittle metal at the fusion line.
2. Strains due to shrinkage of the deposited metal.
3. Strains and distortion due to temperature stresses in the casting.

It is easy to point out that these things are to be guarded against, but it is quite another to be able actually to do it. There are many cast iron jobs that are easy; others are difficult, and still others are impossible with our present limited knowledge. It requires an expert to know in what class any given job comes, and, knowing this, he must plan the method of doing the work so as to minimize or eliminate the troubles listed above. This knowledge cannot be expected in a welding operator. A man who knows that much earns more money. On the other hand, nobody but a trained operator can carry out the instructions given by a man expert in cast iron work.

To go back to the three difficulties, the first one is the hardest to overcome in all but a few instances, because it is due to absorption of carbon from the cast iron by the newly deposited metal. Molten iron has a great affinity for carbon and the cast iron has a lot to spare, so that when the two come together the metal from the welding electrode takes up the carbon and forms a layer of very high carbon steel. To make matters worse, this newly formed steel is quickly chilled by the mass of relatively cold cast iron on which it has been deposited. This combination of very high carbon and extremely rapid chilling makes about the hardest steel that can be imagined.

The only remedy for this effect is to remove the carbon from the surface of the cast iron, but this is easier said than done. In many cases it simply cannot be done by any method known to the writer. There are two methods of removing the carbon and several methods of reducing its ill effects.

The removal of excess carbon from a cast iron surface preliminary to welding requires great skill on the part of the operator. The ordinary soft steel electrode after having passed through the arc is practically carbonless, so that upon coming into contact with the casting it draws carbon. Now, if the welder plays his arc on this freshly

deposited metal, directing it always to the hottest point, he will flow off this high-carbon steel that has just formed and the surface will have just that much less carbon in it. This operation can be kept up until the welder thinks he has removed sufficient carbon to permit the making of a good weld.

It will be readily appreciated that this process cannot be carried out in every case. The casting must have sufficient heat-dissipating capacity and the weld must be so located as to permit the overheated metal to flow clear of the work.

Another way of reducing the action of the carbon is to use a carbon-absorbing flux for flowing the flux out of the weld. In cases where these expedients are not possible, precautions must be taken to prevent the carbon trouble from spoiling the job.

Heating and slow cooling greatly help by reducing the brittleness. Studding the joint prevents failure due to brittleness at the fusion line.

Strains due to shrinkage can be avoided by proper design of the joint supplemented by proper welding technic. Such strains must always occur where the same welding string is fused to cold metal on two opposite sides. The only way to fuse onto opposite sides and not experience trouble is to heat the metal surrounding the weld to permit the distribution of the strain. In some cases there is no other way out.

Strains and distortion due to heat from the welding are often claimed by makers of arc welding equipment not to exist. It is true that compared with oxy-acetylene welding the heat disturbances of the arc are almost negligible, but this is a property of all arcs and not specially enjoyed by any particular type of machine or system.

When there is a lot of metal to be deposited in a small area, preheating must be resorted to. It stands to reason that if an arc is held practically in the same location for hours, as is sometimes the case, unequal heating is bound to take place. Preheating for arc welding is by no means the serious objection that it is for oxy-acetylene welding. In the case of arc welding it simply means playing an ordinary blow-torch on the work until it is warm. It need never be hotter than can be touched with the hand.

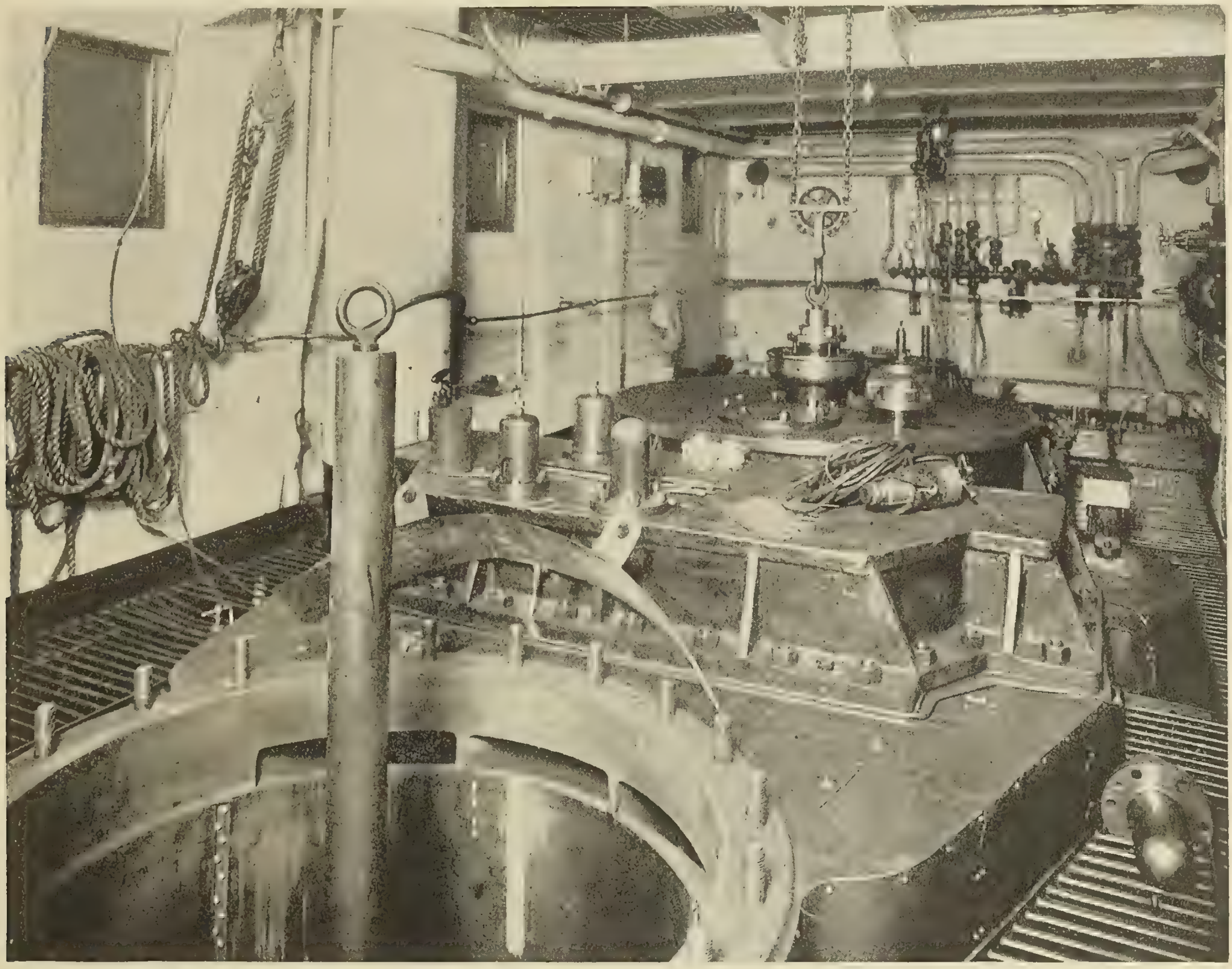


Fig. 1.—Engine Room of Brazilian Steamer *Uberaba*, Where Deep Scores and Breaks in Intermediate Cylinder of Quadruple Expansion Engine Were Successfully Repaired by Electric Welding

Before we get more involved in the technic of cast iron welding, perhaps it would be well to return to the subject in hand. The engine here in question is a quadruple expansion marine type, which develops 4,500 horsepower at a steam pressure of 220 pounds per square inch and normal speed. It forms part of the equipment of the Brazilian steamer *Uberaba*.

The damage consisted of a number of deep scores and breaks in the intermediate cylinder, which is 56 inches in diameter and has a stroke of 50 inches.

Preparatory to welding, the faults were all opened up with a pneumatic chipping hammer so as to expose the

full extent of the damage and to provide sufficient space to assure the possibility of applying proper welding technic in the depositing of the metal. This prepared space was next drilled with a portable drill and the holes tapped to receive studs, as shown in Figs. 2 and 3.

The joint in the vicinity of the work was slightly warmed with a small blow-torch before welding. The torch may be seen in Fig. 1, where it is shown at the left and on top of the low-pressure cylinder.

The electricity and the compressed air were obtained

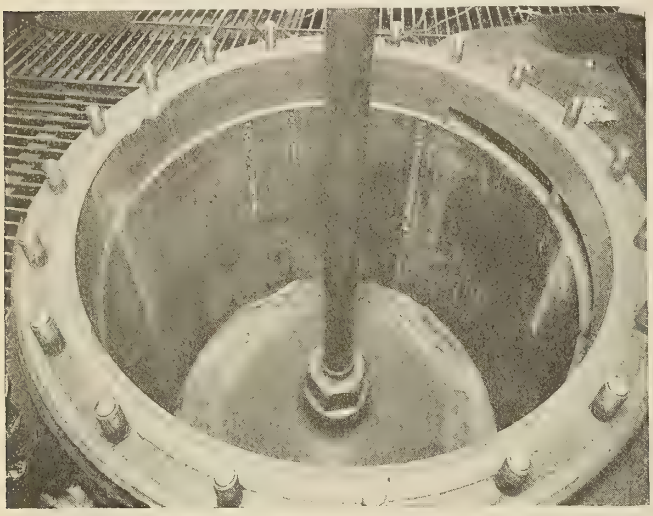


Fig. 2.—Looking Down Into Damaged Cylinder

from the welding company's floating plant, which was brought up alongside the ship.

The welding itself was done with a special coated electrode made in the laboratories of the Electric Welding

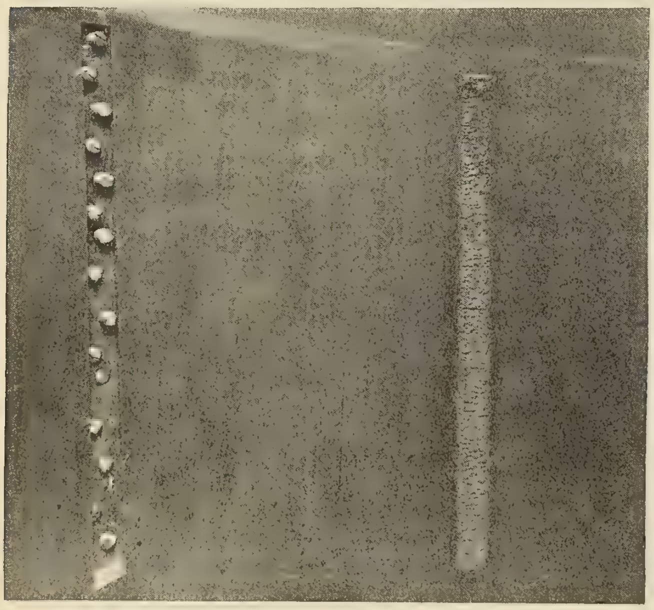


Fig. 3.—"Close-Up" View of the Welds

Company of America. After the welding patch was completed, as shown in Fig. 3, it was ground to true contour by means of a portable grinder and a special gage. While using the arc the valve ports were protected from injury by a sheet metal screen that was hung over two of the cylinder studs.

The illustrations show some of the stages of the work with remarkable clearness. Fig. 1 is a general view of the engine looking along the tops of the cylinders and toward the low-pressure end. The electric cables from the floating plant may be seen hanging down from the deck above. Fig. 1 also shows the blow torch and the portable drill, as well as the screen that was used to protect the valve ports. Fig. 2 looks right down into the cylinder and shows the location of the damaged portions. A number of the faults have been prepared for welding, and one at either side of the picture has been filled with welding material.

Fig. 3 is a "close-up" of the work. It shows how the cylinder is prepared to receive the welding material and also how the welding material looks in place and before it is ground. Once it is ground it becomes invisible except upon very careful examination. There were twenty-five patches put in this cylinder.

Proposed Method of Placing Screens on Port and Starboard Lights

BY E. DE BRUIJN

THE port and starboard lights for steamers, sailing vessels and any other kind of water craft traveling at night play a very important part in navigation, and consequently the screening of these lights is a matter that should receive careful consideration. As we all know, the rules and regulations of navigation prescribe the angle at which the port or starboard light may be seen shall not be less or greater than two points of the compass abaft the beam, and that the light shall be visible directly in front, or, in other words, the rays should be thrown parallel with the centerline of the ship. The angle of visibility is thus 112½ degrees. But we will find that this is not the case if we regard the accompanying sketches of the present way of screening. Compare this with the proposed way and the principle will be evident at once.

Before studying the sketches shown in Figs. 1 and 2, attention should be directed to the law of nature, that if a ray of light passes through space or through a vacuum this ray is not visible, but as soon as same is obstructed in its course by any object it will either go through it or fall upon it, and in both cases this body or particle will be lit up and thus give light.

If we apply this rule of nature to the port and starboard lights we will have three points to consider: (1) The source of light; (2) the rays produced by the source; (3) the lens, or the object through which the rays are thrown.

In Figs. 1 and 2 the source of light is a mazda lamp, which is, of course, of minor importance, as, for that matter, any light will do. Both lenses in Figs. 1 and 2 have the same radius, and also the reflectors are of similar make and design. The only difference in the construction is the placing and length of the screens.

In Fig. 1 the screen *A* and *B* may be of any length, say from one inch up to two or three feet, whatever the condition on board the ship may be, but in Fig. 2 the length of these screens must comply with certain rules, which will be explained later.

The present way of screening is based upon the visibility of the direct rays, produced by the *source* of light, but the indirect rays are also important factors which must not be overlooked.

At present the angle is taken from the center of the *source* of light, which, the writer believes, is in error, because the object that really gives the light is the lens, so that we ought to take the angle produced by the two tangents to the outer side of the lens.

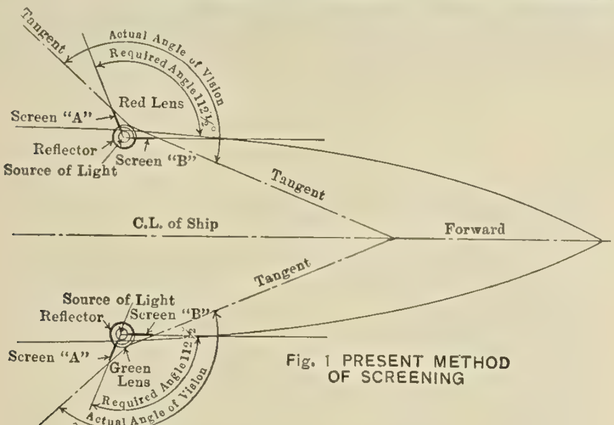
My proposal is to place the screens so that the outer edge of screens *D* will touch the tangent which passes

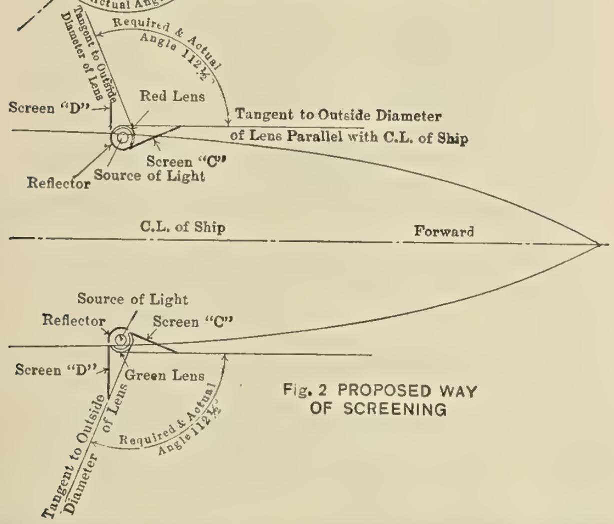
through the outside radius of the lens. This tangent should be at an angle of 112½ degrees with the centerline of the ship.

The same must be the case with screen *C*. The outer edge of screen *C* should touch the tangent passing through the outside of the lens.

This tangent must run parallel with the centerline of the ship. This shows clearly that any size of screen may be fitted as long as the outer edges do not project beyond or fall short of their respective tangents.

It is at once apparent that a slight increase or decrease of the lens radius changes the angle of vision accordingly,





and, inasmuch as very few lenses are of exactly the same dimensions, the screens will have to be carefully located for each individual light installed.

Careful observation of harbor craft and ocean-going vessels has shown that in many cases the lights were visible at a greater angle than that laid down by the laws of navigation, also the port light might be seen on starboard side and vice versa.

Increasing Stoke-Hold Efficiency—II*

The Flue Gas Analyzer

BY A. POHLMAN

In Fig. 1 is shown a partial view of a flue gas analyzer. To simplify matters the solution jars used for *O* and *CO* analysis and the frame, or carrying case, of the instrument have been omitted. By referring to the sketch and mastering the simple details suggested in this article, any type of Orsat or analyzer, irrespective of its size or shape of glass parts, may be successfully operated.

As shown in Fig. 1, the neck of the burette, or gas-measuring device, is connected to the glass header *H* by means of rubber nipples. The burette *B* is inclosed in a glass water jacket *J*, which is filled with water and closed with a rubber stopper *R*, the object being to maintain a constant temperature in the burette. The lower neck of the burette is connected to the leveling bottle *C* by a piece of rubber tubing, the bottle being filled with water. To the left of the burette is the caustic jar containing an inverted glass bell *G*, which, in turn, contains a steel ribbon, as shown, or is loosely filled with steel wool. This jar is half filled with caustic solution and the neck of the bell *G*

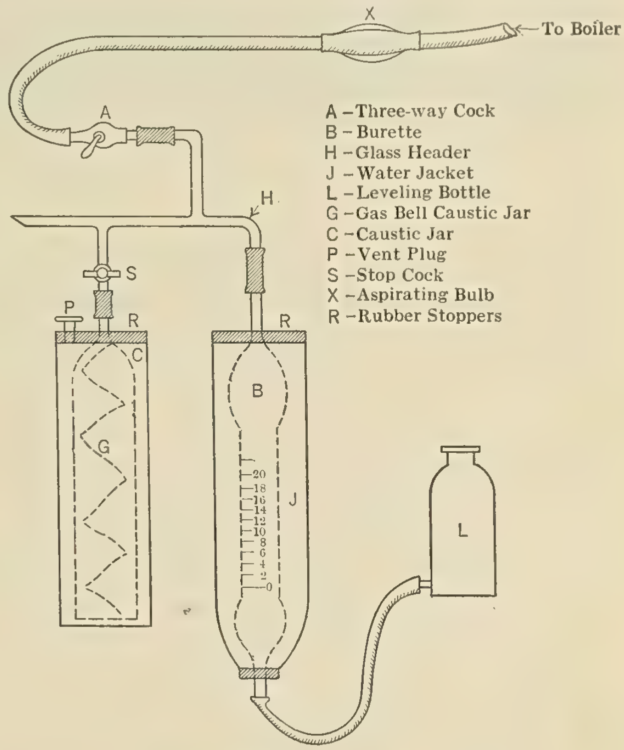


Fig. 1.—Diagram of Flue Gas Analyzer

connected to the header by a rubber nipple. The top of this jar is closed with a rubber stopper which has a vent plug *P*. This plug must always be removed when operating the apparatus.

Two more jars, not shown in the sketch, are provided with the instrument. They are exactly similar to the caustic jar and are connected to the header in the same manner, but they contain different chemical solutions. For reasons stated above, these are not taken into consideration at this time.

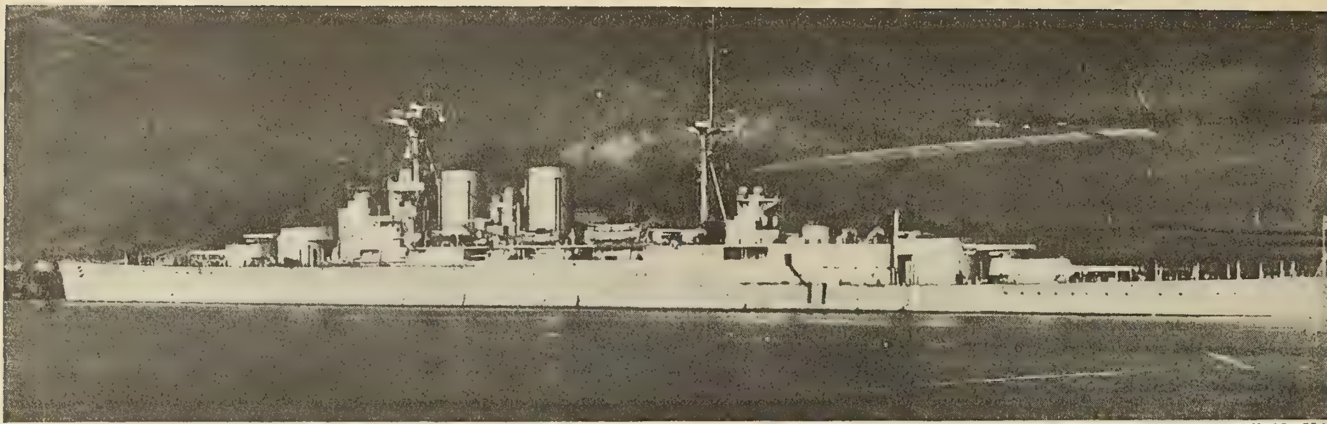
At the top of the header is a three-way cock *A*, on the under side of which is an opening to the atmosphere. To the nipple end a rubber tube leading to the gas sampling pipe is connected. In this tube a rubber bulb is inserted, which is used to pump the gas into the instrument.

Operation

To operate the instrument, the caustic jar is half filled with caustic solution and the stop cock *S* closed as shown. The three-way cock *A* is turned so that it opens to the atmosphere, as shown.

Raise the leveling bottle. As the leveling bottle is lifted the water in the burette will also rise and, acting as a plunger, will drive all the air in the burette ahead of it through the header and out of the vent hole in the three-way cock. When the water reaches a point in the neck of the burette just below the rubber nipple which connects it to the header, close the cock *A* by turning the handle so that it points up instead of down, as shown in the sketch. Remove the plug *P* from the stopper of the caustic

* Continued from December, 1919.



(*Photograph copyright by "International," N. Y.*)

British Battle Cruiser *Hood*. Length, 860 Feet; Beam, 104 Feet; Horsepower, 144,000; Speed, 31 Knots; Main Armament, Eight 15-Inch Guns

jar, open the stop cock *S* and gradually lower the leveling bottle. The water in the burette will then come down and, as it does, the caustic solution in *G* will rise. When the caustic has reached a point in the neck of the bell *G*, just below the rubber nipple connecting it to the header, close the stop cock *S*, then the caustic will remain in the bell.

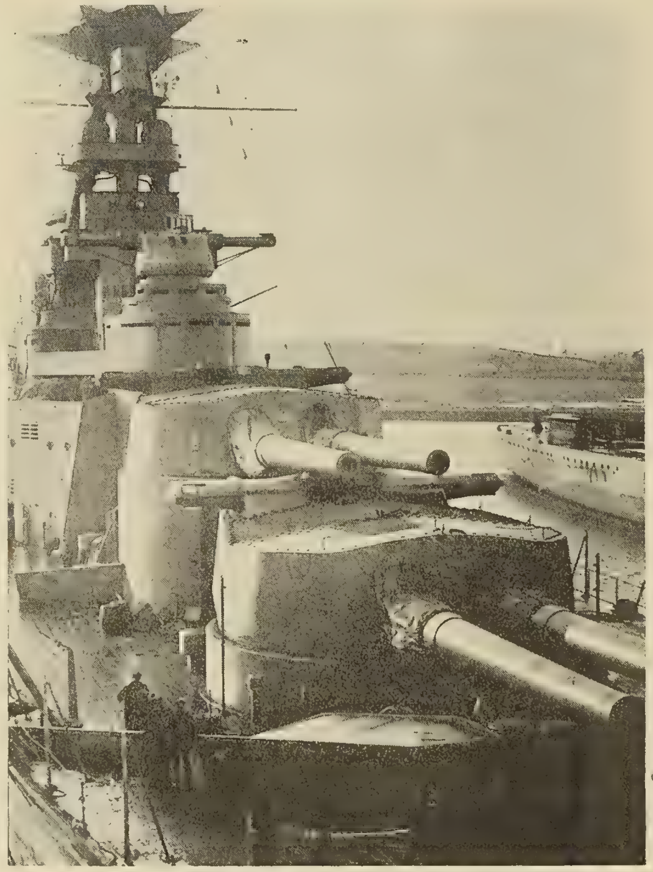
Next create a direct passage for gas from the sampling point, that is, in the uptake of the boiler, by turning the cock *A* so that its handle points to the tube leading to the sampling pipe. Operate the bulb and draw from the boiler a sample of the gases. It will be noticed that the water in the leveling bottle will bubble and a light haze will rise from it. This haze is the flue gas.

When this condition is reached, hold the bottle somewhat below the bottom of the burette, stop pumping and very steadily raise the bottle until the water in the burette stands at the zero mark on the scale. Close the instrument by again placing the handle of the cock *A* so it points up.

We now have a measured sample of gas locked in the instrument. Open the stop cock *S* and raise the bottle until the water in the burette reaches the rubber nipple and again shut the cock *S*. The gas has now been forced over into the caustic jar. The caustic will attack the CO_2 in the gas sample, but it will attack nothing else. In this way the CO_2 will be absorbed. Then open the cock *S* and lower the bottle. Do not pay any attention to the water in the burette this time, but watch the caustic instead, and the moment it reaches its former position in the neck of the bell *G*, near the rubber nipple, close the stop cock *S*.

Coming back again to the burette and leveling bottle; by raising or lowering the bottle, a place will be found where the water in the burette is at the level of the water in the bottle. Read the scale at this point and you will have the percent of CO_2. Part of the gas which at first filled the burette to the zero mark has been absorbed by the caustic and its place in the burette has been taken by water. As caustic absorbs only CO_2, the percentage thus absorbed can be read directly on the scale. As the water and acid levels will appear as curved lines, the reading should always be taken at the lower part of the curve.

As stated earlier in this article, the complete instrument has two other chemical jars in addition to the caustic jar One is operated with pyrogallic acid, which absorbs oxygen, and the other with copperous chlorine, which will absorb the *CO* or carbon monoxide. To get the *O* and *CO* the same sample of gas in which the CO_2 has been extracted is used. Simply open the stop cock over the jar and force the gas from the burette into the jar by raising the leveling bottle. In analyzing for *O* and *CO*, allow the gas to remain in the solution about five minutes before drawing it back into the burette for reading. The difference between the CO_2 reading and the next reading is the percentage of oxygen in the gas. The same process is repeated for *CO*.



(*Photograph copyright by "International," N. Y.*)

Forward Turrets of the *Hood*

Suggestions

Always make certain that all air is cleared out of solution jar bells and that it is replaced with the necessary solution well up in the neck of the bell.

Be sure to clear the burette of air by having the water well up in its neck before drawing the gas sample.

Never have more than one cock open at a time and make certain that all others close airtight.

Development of Warrior River Barge Canal

BY MAJOR ROBERT S. THOMAS, CORPS OF ENGINEERS, U. S. A.

After nearly fifty years of investigation, experimentation, maintenance and progressive construction, the Federal government has provided for the southern coal and iron region of the Birmingham district and for the timber and farming sections of western Alabama a canalized river that offers for over four hundred miles facilities for navigation not possessed to so great a degree by any other system of inland waterways in the United States. This article gives a brief account of the development of this waterway, shows the volume of commerce which it carries and describes the development of transportation methods giving details of the present vessel equipment. A second article, to be published in the next issue, will take up the question of terminals and transfer facilities and future prospects for the commercial development of the waterway.

THE magnitude of the great Mississippi river system of inland waters, draining all of the basin between the Appalachian and Rocky mountains, north of Tennessee's southern boundary, and a vast area west of the Father of Waters, has obscured the public attention to the fact that this country possesses also a river system of no mean magnitude and extent draining a basin that extends from Western Georgia to Central Mississippi. This system finds its outlet to the Gulf of Mexico through the Mobile river and Mobile bay. The navigable waterways of this system are as follows:

The Mobile river with navigable depth of 27 feet (project depth of 30 feet soon to be provided) for about 5 miles from the mouth of Chickasaw bayou, the upper limits of the harbor of Mobile, and 17 feet for the remainder of the 45 miles from the mouth to the junction of the Alabama and the Tombigbee rivers, which join and form the Mobile river.

The Alabama river, with navigable depth of about 3 feet for 271 miles to Montgomery, Ala.

The Coosa river, which is formed at Rome, Ga., by the junction of the Oostanaula and Etowah rivers, and flows in a southwesterly direction through Georgia and Alabama for a distance of 282 miles, uniting with the Tallapoosa to form the Alabama about 22 miles above Montgomery, the present navigable depths at low waters being 4 feet over certain improved sections, 3 feet to Gadsden, Ala., and 2½ feet to Rome, Ga.

The Tombigbee river from its junction with the Alabama over the canalized stretch to the mouth of Warrior river near Demopolis, Ala., 185 miles, having a guaranteed navigable depth of 6 feet the year round and a practical depth of 8 feet except in the period of extremely low water. From the mouth of the Warrior river to Walkers Bridge in Mississippi, a distance of about 303 miles, the stream is not canalized and navigation, except at high water, is limited to shallow draft boats and rafting. For about four months in the year boats drawing 5 feet can navigate to as far as Columbus, Miss., 149 miles, but actually boats seldom go beyond Pickensville, Miss., 114 miles above the mouth. Federal improvement is limited to snagging and removal of obstructions.

The Warrior river, which has been completely canalized from its junction with the Tombigbee river near Demopolis for a distance of 131 miles to Tuscaloosa, Ala., where the name of the river changes to that of Black Warrior, though it is the same stream, thence 47 miles to the junction of the two forks of the Black Warrior, the Mulberry Fork and the Locust Fork, thence up these forks to Saunders Shoals on the Mulberry Fork, 36 miles, and to Nichols Shoals on the Locust Fork, 16 miles.

Thus there is provided a navigable waterway of a minimum 6-foot depth (practically 8 feet) for a distance of about 420 miles from the coal fields of Alabama to tide water at Mobile. Table I gives the location and other data for the locks in this system.

This improvement, carried out by the Government, has cost to June 30, 1919, for the earlier projects prior to the existing project:

For new work	$606,930	(£ 126,500)
For maintenance	50,000	(8,200)
Total	$656,930	(£ 134,700)
For the existing project:		
For new work	$9,367,564	(£1,920,000)
For maintenance	216,663	(44,400)
Total existing project	$9,584,227	(£1,964,400)

TABLE I.—LOCATION AND DETAILS OF LOCKS

Lock No.	Distance from Mobile.	Nearest town.	Distance.	Width of chamber and greatest length available for the full width.	Lift.	Depth over sills at low water.
	Miles.		*Miles.*	*Feet.*	*Feet.*	*Feet.*
1	111	St. Stephens, Ala.	3	281.9 by 52	10.00	6.5
2	182	Pennington, Ala.	6	286 by 52	10.00	6.5
3	205	Oakchia, Ala.	5	do.	10.00	6.5
4	231	Demopolis, Ala.	1	285.6 by 52	10.00	6.5
5	246	Cedarville, Ala.	5	do.	10.00	6.5
6	267	Sawyerville, Ala.	5	do.	10.00	6.5
7	282	Wedgworth, Ala.	5	284.7 by 52	10.00	6.5
8	298	Akron, Ala	3	284.7 by 51.65	10.00	6.5
9	315	Powers, Ala.	4	284.7 by 52	10.00	6.5
10	362	Tuscaloosa, Ala		286.6 by 52	9.86	6.5
11	362	do.		286 by 52	8.50	6.5
12	363	do.	1	286.2 by 52	10.50	6.5
13	370	Tidewater, Ala.		285.5 by 52	12.14	6.5
14	373	Searles, Ala.	8	282.1 by 52	14.00	6.5
15	380	Kellerman, Ala.	6	do.	14.00	6.5
16	387	do.	14	285.5 by 52	21.00	6.5
17[1]	388	do	14	do	63.00	6.5

Lock No.	Character of foundation.	Kind of dam.	Type of construction		Date of completion.	Actual cost of lock and dam.
			Lock.	Dam.		
1	Soft rock	Fixed	Concrete	Concrete	1909	$560,290.02
2	Hard clay	do.	do.	Timber crib, stone	1915	560,114.09
3	do.	do.	do.	do.	1915	609,622.80
4	do.	do.	do.	do.	1908	479,000.00
5	do.	do.	do.	do.	1908	501,000.00
6	Piles	do.	do.	do.	1908	443,000.00
7	do.	do.	do.	do.	1903	225,600.00
8	do.	do.	do.	do.	1903	212,400.00
9	do.	do.	do.	do.	1902	202,440.00
10	Hard sandstone	do.	Stone	do.	1895	244,500.00
11	do.	do.	do.	do.	1895	170,000.00
12	do.	do.	do.	do.	1895	160,500.00
13	do.	do.	do.	Stone	1905	203,700.00
14	do.	do.	Concrete	Concrete	1910	414,714.89
15	do.	do.	do.	do.	1910	430,233.87
16	do.	do.	do.	do.	1915	520,853.68
17[1]	do.	do.	do.	do.	[2] 1915	[3] 3,115,520.36

[1] Double lock.
[2] Opened to navigation in 1915. Now 99 percent completed, the remaining 1 percent covers cost of submerged land.
Estimated cost. Payments for submerged lands not completed. Cost to January 1, 1918, $3,042,242.42.

For the operation and care of locks and dams after completion of construction	$1,992,132	(£ 409,000)
Total cost of construction, maintenance and operation	$12,233,289	(£2,510,000)

At the present time it is costing about $250,000 (£51,250) per year for the operation and care of the system of locks and dams, and from $150,000 (£30,800) to $200,000 (£41,000) for snagging, dredging of bars, strengthening of dams by the deposit of heavy stone below dams, widening of channel at sharp bends by dredging and the construction of certain additional guide cribs and other items of new work and maintenance.

A recent act of Congress has provided for the placing of permanent flash boards upon certain dams, thus raising the pool of the dams two feet and actually providing for an 8-foot channel. The project width of 150 feet, wherever practicable, has been authorized. The work of installing the flash boards has been started and on several of the dams completed. Very satisfactory progress was made the past season in dredging out the bars where the 8-foot channel has narrowed, as well as in dredging at the sharp bends. To all practical purposes this channel now affords the guaranteed depth of 6 feet and a minimum width of 125 to 150 feet all the year round.

Commerce

The records of the commerce upon this river are not entirely satisfactory for the purpose of drawing definite conclusions. The method of procuring and reporting these statistics has varied from time to time, and it is not always clear as to exactly what portion of the traffic is through traffic and what is local. It is also believed that some of the earlier figures given have not taken into consideration the log rafts that are floated down this river in no inconsiderable volume. Some years the traffic was reported in bales of cotton and the remainder of the traffic estimated sometimes in tons, sometimes in tons and value, and sometimes in ton-miles. Subject to the foregoing remarks, the following table of the commerce on the Warrior-Tombigbee River System for the years 1916-1918 is given:

TABLE II

Calendar Years	Total Traffic, Tons	Value, Total Traffic	Coal, Tons
1916	457,109	$4,668,783	154,710
1917	580,788	5,891,861	158,076
1918	671,405	6,168,975	....

Total Volume of Traffic

The high mark was in 1877 with a traffic estimated at over $10,000,000 (£2,050,000). The volume then declined to a minimum of 37,000 tons at a value that probably did not exceed $1,500,000 (£308,000). There appeared to have been a temporary revival of water traffic, culminating in 360,000 tons at a value of about $5,000,000 (£1,025,000) in 1900, followed by a collapse to 144,000 tons in the fiscal years 1901 and 1902, valued at about $2,000,000 (£410,000). Then followed a revival to 1909 with 639,041 tons, valued at from $9,000,000 (£1,845,000) to $10,000,000 (£2,050,000). This was followed by a gradual falling off to 270,000 tons in 1913, valued at less than $4,000,000 (£820,000). The recent years of 1916, 1917 and 1918 show a pleasing and progressive growth to 671,000 tons in 1918, valued at over $6,000,000 (£1,230,000). The statistics for 1919 are not yet available.

After a study of the commerce transported on this river and the failure of the volume and value of the traffic to respond to expenditures for the improvement, we must rather admire the courage and the far vision of the engineers who recommended and of those Congresses that made the liberal appropriations, rather than condemn the caution of those Congresses that failed to provide for the more rapid progress of this development.

The public at large or locally has not yet fully awakened to the possibilities and economies now possible from the full utilization of this project. The development of water transportation, then the decline of water transportation coincident with the development of railroads, and then the renewed development of water transportation in conjunction with and supplementary to the railroads are three normal steps in the national development of the transportation system of every nation. In view of these facts it would seem that this development has progressed even more rapidly than the ability and the will of the public to avail itself of this improvement and that the care and caution and time required have been fully justified by the stability and practical possibilities of this development as it exists today.

Development of Transportation Methods

The western river stern-wheel type of boat is still holding its own on this river as on other inland rivers of this country, and there are numbers of them in commercial use besides the snag boats and towboats belonging to the fleet of the United States Engineers and to the United States Railroad Administration.

The *Peerless*, a sternwheel packet boat of the Burke Packet Company, operates weekly, except at extreme low water, from Mobile to Selma, Ala., on the Alabama river. It is understood that they have all the business they can handle. They make all-way landings and handle a general cargo and passengers. Roustabouts are used for loading and unloading.

The sternwheel packet boat *John Quill* is operated by the Merchants Transportation Company, making weekly trips up the Tombigbee river as far as Demopolis, stopping at all-way landings, which are numerous. They are apparently finding plenty of business. They handle a miscellaneous cargo and a passenger service. Roustabout labor is used for loading and unloading on the river banks. At many of the landings are small warehouses and inclined tracks with one small flat car operated by cable attached to a hand windlass.

Data as to the volume of traffic and cost of operating these packet boats are not available. They seem, however, to be having a good business and are understood to be making expenses. With the general nature of the cargo in small lots to way stations and with the greater cost of labor, both unskilled and skilled, it is not probable that any large profits are made. The fact that these boats are operating is, however, a favorable sign and shows the need for water transportation and an awakening of public interest in inland waterways.

There are a number of western river type sternwheel towboats privately owned, operating principally in the handling of logs and lumber to and from the many saw mills along the river. Among these may be mentioned the *Twilers* at Akron, Ala., owned by the Black Warrior Lumber Company; the *Hale*, owned by John C. Webb and Sons, of Demopolis, and the *Baldwin*, owned by Captain J. Baker, at Tuscaloosa, Ala. In some instances the logs are rafted to the river bank near the saw mill, but generally they are loaded on barges by a derrick boat or by skids from the bank, and are towed to the mill, where they are hoisted out of the water by a stiff-leg derrick and steam-hoisting engine. There is still much timber standing, and this industry may be expected to thrive for many years to come.

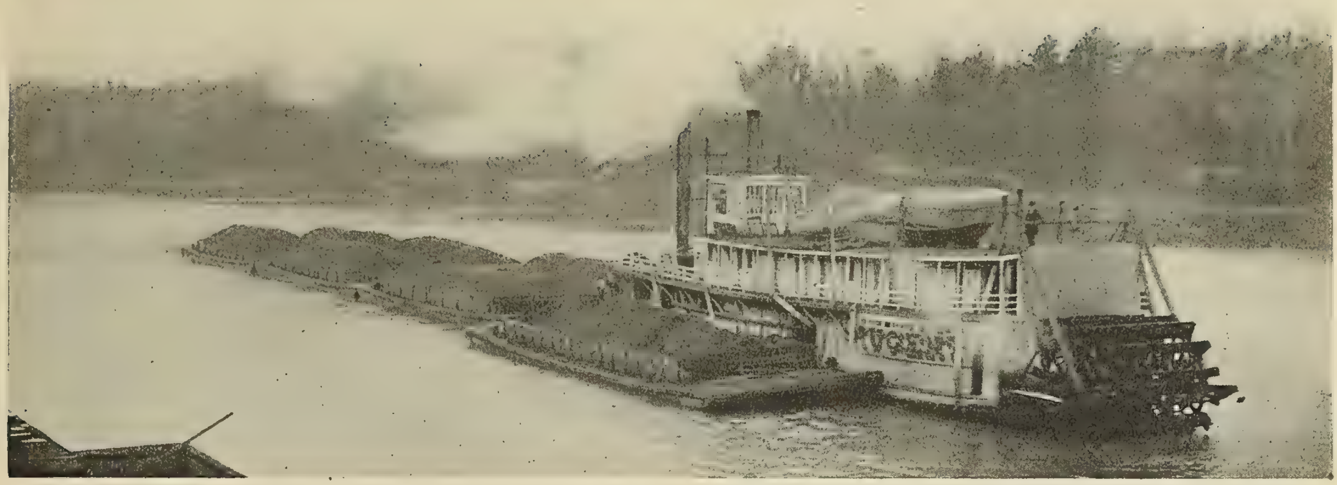


Fig. 1.—Steamer *Nugent* Leaving Tuscaloosa, Ala., with Tow of Seven Barges of Coal

The Plant of the United States Railroad Administration—Warrior River Section

When the United States Railroad Administration took over the operation of the Mississippi-Warrior waterways as a war measure they naturally did not delay the movement of coal until steamboats and barges could be designed and constructed to give the maximum service for minimum operating costs, but purchased what plant was available. This plant included three sternwheel towboats, western river type, the *Clio, Darling* and *Volcano;* forty-three open wooden coal barges, each 140 feet long (eleven of which are 24 feet wide and thirty-two are 25 feet wide, twenty-three are 8½ feet deep and twenty are 10 feet deep); five self-propelled steel coal barges (of which three are 220 feet long, one 200 feet long, and one 240 feet long; all are 32 feet wide by 8 feet deep); two unloading machines, locomotive-crane type operating 2-ton clamshell buckets, located at the transfer point at Mobile for transporting the coal from wooden river barges and self-propelled barges to one self-propelled barge for shipment to New Orleans by way of Mobile bay, Mississippi sound, Lake Borgee canal to the Mississippi river at Violet, near New Orleans.

The towboats and certain of the old wooden coal barges required extensive overhauling and repairs. Twenty of the wooden coal barges are new, having recently been constructed under contract by the Murnan Shipbuilding Company, of Mobile. The repairs to the old

Fig. 2.—Steamer *John Quill* Unloading Cargo at Tuscaloosa

Fig. 3.—Steel Container Loaded with Sugar in Sacks

plant were made at the United States Engineer yards at Tuscaloosa and Pascagoula, the actual cost and overhead being reimbursed by the United States Railroad Administration.

In addition to the above-mentioned equipment, the Warrior section has twenty steel containers 8 feet by 8 feet by 9 feet, designed to fit on flat cars and barges, with wire cable in top for handling. They are also equipped with end ladders and top foot-ways, so that when placed on a flat car the car becomes to all purposes a box car. The doors to each container are double and can be locked, thus making the containers both weatherproof and thiefproof.

It is contemplated to use these containers especially for upstream shipments of such perishable commodities as coffee, salt, sugar, flour, grain and merchandise that will originate in New Orleans and Mobile and be shipped to such distributing centers as Demopolis, Tuscaloosa and Birmingham. These containers can be loaded either at the transfer points at Violet near New Orleans and at Mobile or at the factories and warehouses and then transferred by flat cars to the water terminals, where they can be loaded on the barges by derricks. It is proposed that these containers will be unloaded by derricks provided by the local interests. The empty containers will be brought back on top of the downstream load of coal. It is understood that 200 additional containers have been ordered.

Loaded with sugar, these containers hold about 10 tons net. Fig. 3 shows one of these containers loaded with sugar in sacks, showing the double doors and weatherproof and thiefproof advantages of such a container. Fig. 4 shows the containers on a flat car being loaded with sugar in barrels. Fig. 6 shows the containers being transferred from the flat cars to one of the self-propelled barges by means of a derrick. The derrick did not prove strong enough for the load, so that No. 4 self-propelled barge is now being converted to a derrick and conveyor barge for use at the transfer point at the New Orleans terminal.

Sternwheel Towboats

The sternwheel towboats have been operating from the mines to Mobile with the wooden barges loaded with coal in tow. They handle three and four barges per tow, breaking tow at the locks, the towboat and four barges

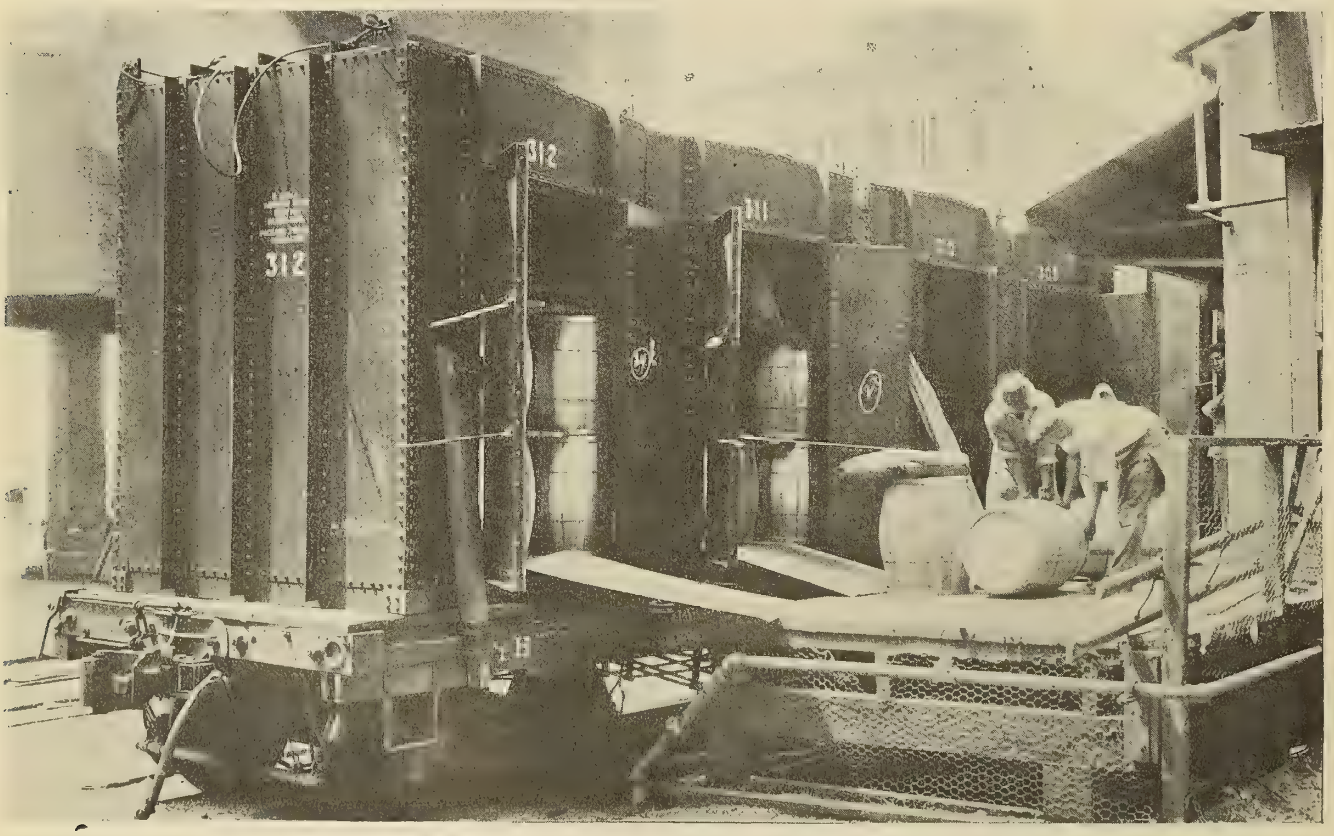


Fig. 4.—Steel Containers on Flat Cars Being Loaded with Sugar in Barrels

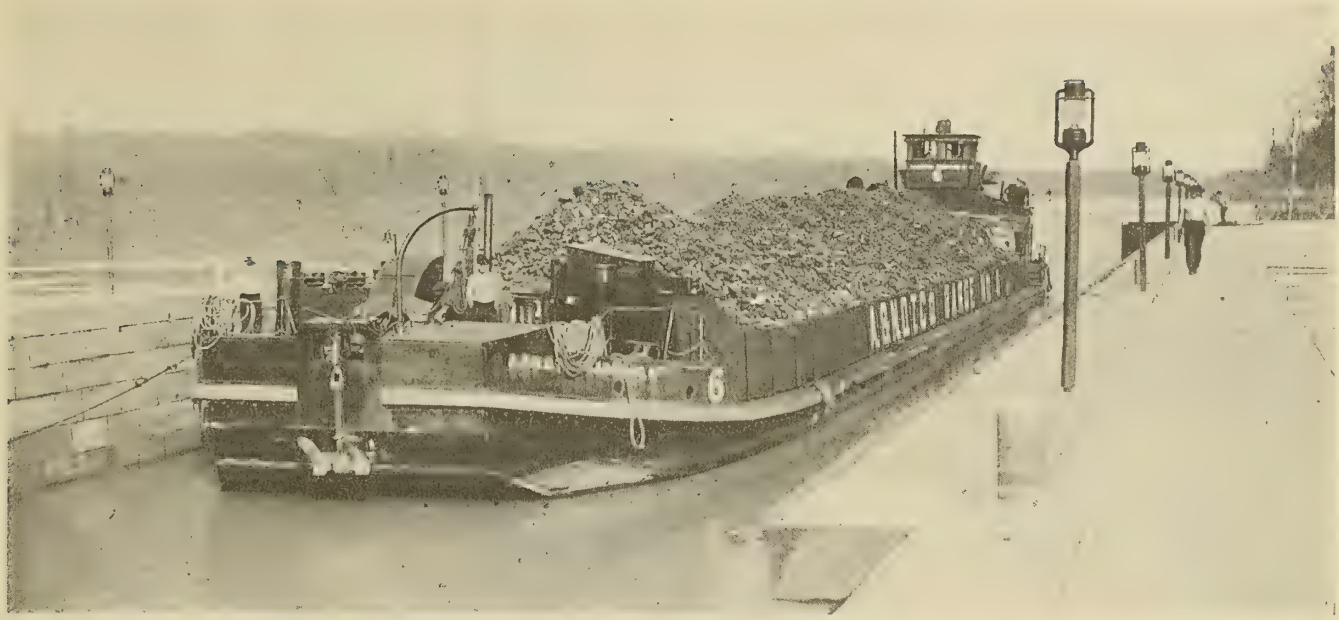


Fig. 5.—Self-Propelled Barge *No.* 6 in Lock No. 11, Black Warrior River, Ala.

being passed in two lockages. For some time past it has been the intention to experiment with the plan of having the *Darling* and the *Clio* bring four barge tows from the mine to below lock No. 1, there to be assembled into eight barge tows and brought to Mobile over the wider and less restricted river by the larger towboat *Volcano*. Recently these cargoes of coal have been supplemented with a top cargo of large dimension timbers for export purposes.

Self-Propelled Barges

Of the six self-propelled barges, four are operated from the mines to Mobile and one transfers from Mobile to New Orleans, the coal being handled by clamshell buckets at Mobile. Barge No. 4 is being converted at New Orleans into a derrick and conveyor barge. Nos. 1, 2, 3 and 4 are 200 feet long; No. 5 is 240 feet long, and No. 6 220 feet long. All are 32 feet wide and 8 feet deep. Their estimated carrying capacities are 735 and 850 tons on a 6-foot draft.

The vessels are constructed of steel plates and angles, and the load is carried on deck. Each barge carries its own power, which is a gas producer, and two producer-gas engines of 75 horsepower each. The fuel used is nut coke, and each barge consumes about 1¼ tons per day. The engines run in opposite directions, make about 300 revolutions per minute, are about 12 feet apart and drive 3-blade propellers 42 inches in diameter with 30 inches pitch. Each barge has three rudders, the middle rudder balanced.

These barges handle very well, but have insufficient backing power. One of the upper lock gates was recently rammed by one of these barges, but without material damage.

New Equipment

Besides the twenty open coal barges 140 feet by 25 feet by 10 feet recently constructed by the Warrior Shipbuilding Company, the new equipment now under construction includes:

(a) Three steel tunnel-type towboats, 140 feet by 24

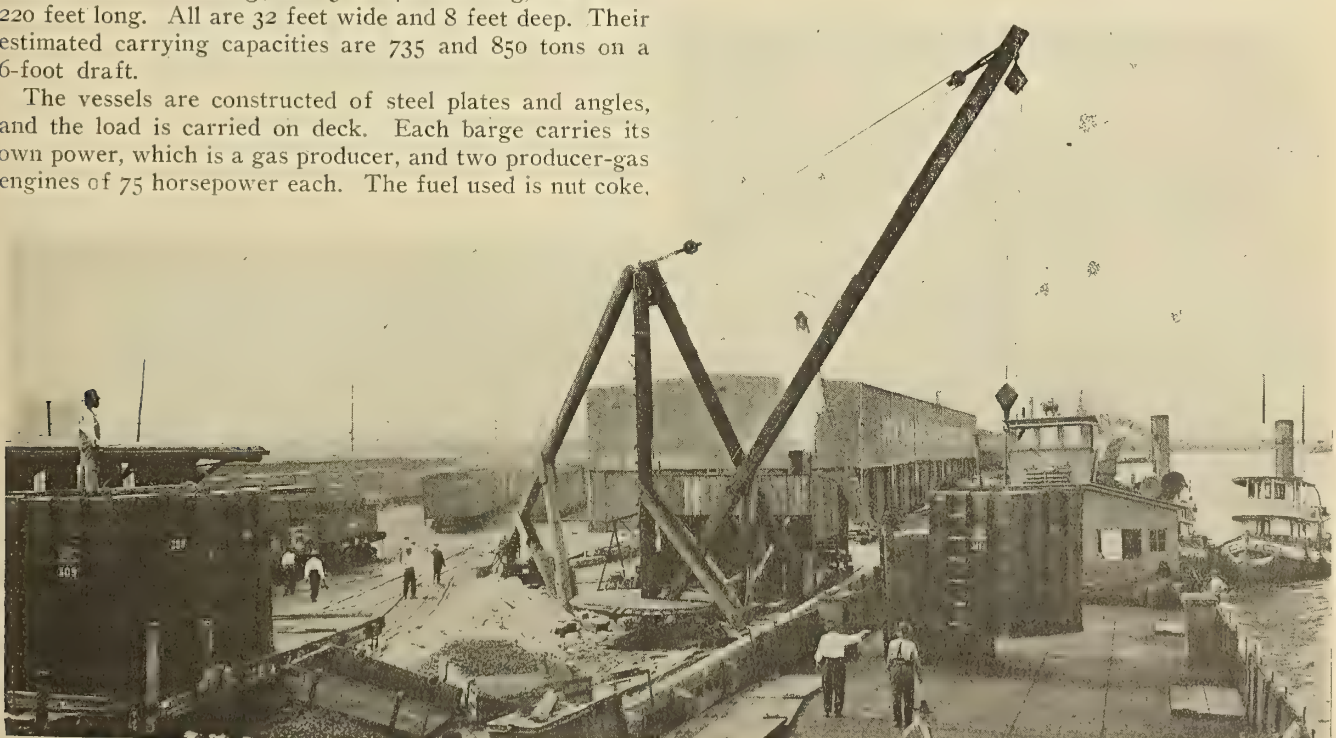


Fig. 6.—Transfer of Steel Containers from Flat Cars to Deck of Self-Propelled Barge at New Orleans

feet by 8 feet 9 inches, of 6 feet maximum depth of hold.

(b) Four self-propelled steel barges, tunnel type, 280 feet by 49 feet by 10 feet.

(c) Two hundred steel containers and more as needed.

Detailed descriptions and plans of the towboats and barges are given on page 674 et seq., of Marine Engineering for October, 1919. The specifications provide for a "single deck, shallow draft, twin-screw tunnel towboat, built of steel, with a continuous deck house about 112 feet long. House on deck to accommodate major portion of crew, galley, mess room, lavatories, coal bunker and machinery. House on the upper deck forward to contain living quarters for the captain and a spacious pilot house. Total number of crew, 16.

"Rudders to be arranged forward and aft of the propellers.

"Propelling machinery to consist of two 400-horsepower, vertical, triple-expansion engines, two watertube boilers and the necessary auxiliaries.

"Vessel to be fitted with one mast to carry light heavy towing bits, capstans, cleats, fairleads, chocks, fenders and guards.

"Vessel also to be fitted with electric light plant, steam steerer and complete outfit to pass United States Inspection requirements."

The two propelling engines are to have an 18-inch stroke and diameters of 10¾ inches, 17 inches and 27 inches for high-, intermediate- and low-pressure cylinders respectively. They will be designed and built to operate with a working steam pressure of 225 pounds gage per square inch, at a piston speed of 600 feet per minute and develop 400 indicated horsepower at a normal speed of 200 revolutions per minute.

The propellers are to be four-bladed, twin-screw right and left hand, made of cast iron 6 feet in diameter and about 5 feet 6 inches pitch.

The two boilers are to be of the marine watertube type, designed for at least 225 pounds per square inch working pressure, approximately 1,400 square feet of grate area, to evaporate not less than 15,000 pounds of water per hour at 225 pounds per steam pressure, with forced draft of 10,000 cubic feet of air at 1 inch water gage and feed water at 200 degrees F. The boilers are to be hand-fired.

The auxiliary machinery includes a condenser with a centrifugal circulating pump driven by direct-acting 6-inch by 6-inch engine; an air pump; two feed pumps of the vertical simplex extra heavy type, 5-inch water cylinders, 8-inch steam cylinders, 12-inch stroke; fire and bilge pump; sanitary pump; feed water heater; a 2-inch injector for each boiler, etc. For feed water there is provided in the hold forward of the boiler room bulkhead and aft of the engine room a 40-ton tank for fresh water. River water is to be used for boiler feed only in emergency. The boat will be steam-heated and lighted with electricity.

Twin-Screw Steel Tunnel Self-Propelled Barges

The four steel self-propelled barges 280 feet by 49 feet by 10 feet with maximum draft of 7 feet are each to be equipped with two vertical expansion engines with cylinders 10¾ inches by 17 inches by 27 inches diameter by 18 inches stroke, working at 225 pounds steam pressure and developing 400 horsepower at 200 revolutions per minute as described for the towboats. The boilers and auxiliaries are in general similar to those for the towboats.

An interesting feature about these self-propelled barges is their sizes, designed to get the maximum practical benefit permitted by the size of the lock chambers, which have the controlling dimensions of 281.9 feet available length and 51.65 feet available width. There is being discussed from time to time the question of whether or not it would be practicable to use boats through these locks with a width of 50 feet or even 50 feet and 6 inches.

(To be concluded.)

Standards for Ship Construction

How Workable Standards Are Determined—Data Presented in Form of Graphs—Planning and Scheduling Methods

BY CREIGHTON CHURCHILL*

THE writer was recently engaged in an exhaustive engineering investigation of a shipyard which afforded the opportunity of putting to practical use the methods advocated by him in a paper on "Steel Ship Construction from a Management Viewpoint," read at the last annual meeting of the Society of Naval Architects and Marine Engineers. The results of this investigation indicated the urgent necessity of setting up standards to work to and the data secured, worked up in the form of graphs, present the subject to the readers of Marine Engineering in a way that cannot fail to bring to their attention the fact that such a necessity really exists and is worthy of the most serious consideration by shipyard executives.

Standards are the basis of intelligent estimating. Without them estimating can only be based on past performance, a method that fails to consider all the elements involved. Prices quoted on such a basis are not sufficient, particularly in the newer yards which have not yet entered the competitive field or are about to enter that field with young organizations and only experience under normal conditions to rely on. For example, during the war, expense was less than a secondary consideration. This was followed by forced economies and uncertainties as a result of the armistice. Due to these two extremes, the shipbuilding industry in this country today is in anything but a normal state. The reconstruction period looked forward to immediately after the cessation of hostilities has hardly yet got a fair start. The business world is still "topsy-turvy," and nothing but faith in the belief that eventually a way out will be found is keeping the wheels of industry moving.

Under such conditions it behooves the executive to keep in close touch with events from day to day. In any manufacturing industry the simplest and most effective way to do this is to set up reasonable standards and then exert every resource of the organization to make them accom-

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plished facts. It will not do to establish standards in a haphazard way or by what some other plant in the same business has done. They must come from an analysis of actual existing conditions and of necessity should change as conditions change, having due regard for fair play with labor. For example, a standard set for machining a forging with high-speed steel would not hold if ordinary tool steel were used. In the same way standards set for an old-established organization composed of tried and skilled men would not answer in a new organization which has not yet found itself. Yet both should have standards in order that the executives may keep in close touch with daily activities. No greater mistake can be made than that of setting up standards which are unattainable. Such a proceeding is unfair any way it is looked at and is bound to discourage not only the workmen but the sub-executives on whom so much depends.

Shipyards, in spite of the generally unsettled conditions, are in a very favorable position, due to the fact that ships are needed now. This does not mean that orders for them will be placed regardless of cost. In fact, quite the contrary is so and orders are placed only after the most careful consideration. This means that the shipowner is going to get what he wants as a result of keen competition, which, in turn, means that the industry as a whole is on a purely competitive basis and the yard that knows its business best is going to get the work.

As an example of this, attention is called to Fig. 1, which shows the relative costs of a 9,000 deadweight ton cargo vessel for different times of building, the number of men employed being the same. In other words, with the building time standardized, some idea can be secured of what the men must do in the way of fabricating, erecting and riveting. These, in turn, will be standards in order to meet the building programme. Naturally, in this particular case, the question of time required to build the ship is entirely a matter of man efficiency, the number of men employed being the same. The question, therefore, resolves itself into one of finding an attainable standard of man performance, the answer to which is found in the records of past performance, intelligent estimating and a careful study of existing conditions.

As a guide, but only as a guide, known performance in other yards is useful for the simple reason that it may help to account for many things and point the way to weaknesses to be corrected. With this purpose in view, the Emergency Fleet Corporation published many records of performance, and there is little doubt that such a policy had a very good effect. Aside from its aspect as a sporting proposition, it gave many executives food for serious thought, which, in itself, is usually productive of results.

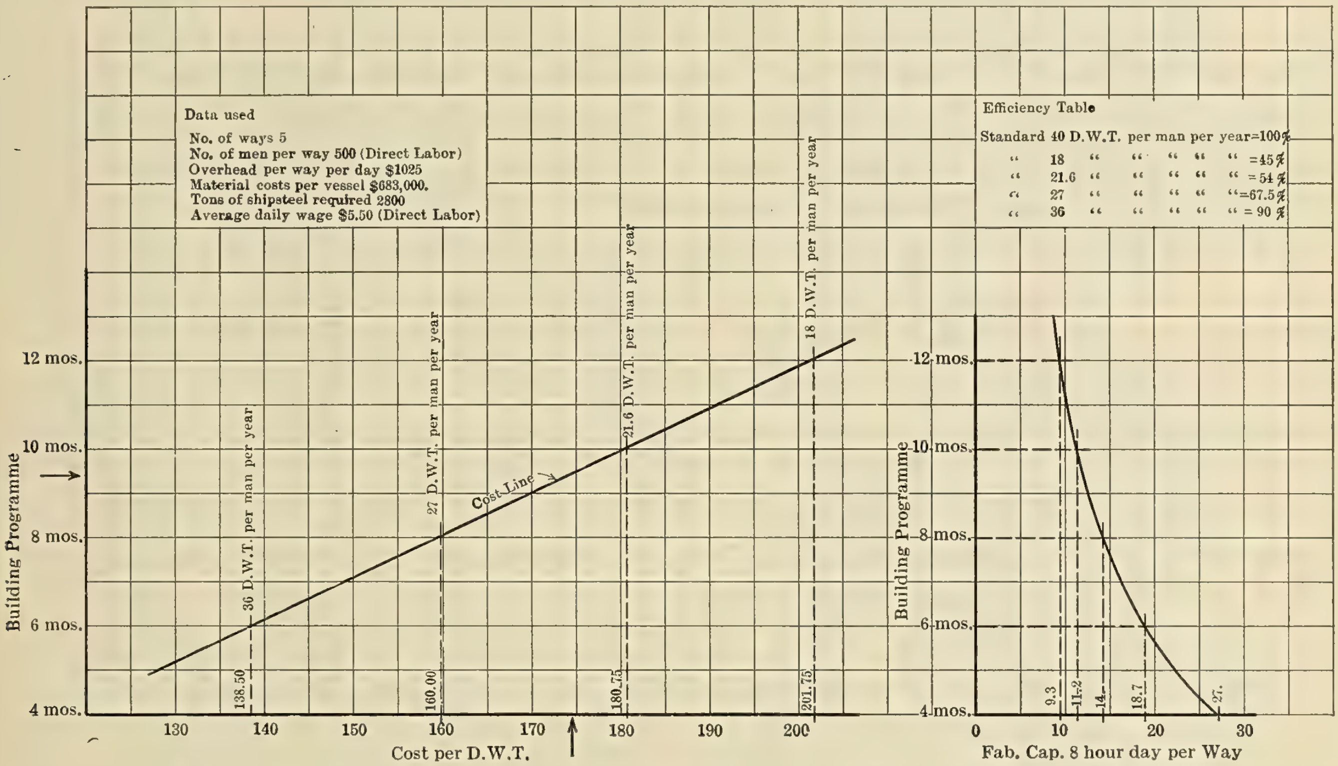


Fig. 1.—Chart Showing Relative Costs of 9,000 Deadweight Ton Cargo Vessel for Different Times of Building, the Number of Men Being the Same

Such serious thought as was developed might have been called by different names, but there can be little question that it had to do with "standards" in some form or other. Even as a sporting proposition—the desire to beat the other fellow—a mark is set up to shoot at, which, for the time being, is the standard—the goal which it is hoped will be reached, if not beaten.

Standards are logical as well as psychological—logical because something definite is set up to be attained, and psychological because it is human nature to have some curiosity about the accomplishment of others in the same line of work. An example of this in current shipyard practice is to play one boat foreman against another to speed up hull construction. This is introducing the sporting element; but, if not accompanied by a set of standards covering the various elements of hull construction, the onus falls entirely on the boat foreman, whereas the management should bear its share. By having, in the first place, a standard method of hull construction backed up by standards of performance for the men, the sporting element can still be retained, but each boat foreman will be relieved of the necessity of *both planning and executing his own work*. In other words, if the management does

its part, the boat foreman is free to exercise his legitimate function, which is to execute.

As an illustration of how such methods work out in practice, a personal experience of the writer may not be amiss. While directing the installation of planning and scheduling methods in a large New England industry some years ago some difficulty was experienced in securing the co-operation of a departmental foreman, largely due to the fact that the man was very much overworked. It had been the habit of the sales department to feed him with orders affecting his department as fast as they came in and hold him responsible for keeping delivery promises made without consulting him. A large part of his time was taken up at the telephone answering "kicks," and the balance in an attempt to shuffle his orders to get the best results. The situation can be well imagined when it was found that something like 85 percent of the orders on his desk had a red "rush" tag attached, and the total of all his orders meant over two weeks' output. His opposition to more modern methods was overcome, and after some two or three months' operation under planning and scheduling, outside of his own department, he said to me, "Mr. Churchill, it seems like I'd lost me job, barring seeing that them ginks and harps do their work." Incidentally, the output of his department was increased 40 percent and costs reduced 23 percent as a direct result of the methods installed.

Planning and Scheduling Comes First

The basis, of course, for this improvement was standards, which were carefully worked out after planning and scheduling were introduced, which, in turn, brings up the very important point that standards cannot be definitely set until after the necessary preliminary work of planning and scheduling has been done. This is but another way of saying that standards in themselves will not accomplish the best results. Their value is largely enhanced when all elements of an industry are properly co-ordinated. This is obvious, if account is taken of the delays caused by one department failing to supply material to another when wanted. These unforeseen delays, when reduced to a minimum by effective methods of planning and scheduling, release productive time, and hence enable standards to be set that otherwise would appear unattainable, if referred to past records alone. This indicates the reason for doing the planning and scheduling work first. Estimates will be similarly affected, hence the desirability of proper standards.

To establish proper standards takes time and, as a general rule, necessitates the employment of properly qualified experts to direct and supervise the work involved, which must be done without interrupting current activities or causing any confusion. While strongly advocating the necessity for such work in shipyards, based on the results of many years of experience in other and varied industries, it fortunately happens that data are available that can be used to advantage if properly applied, though the results obtained should in no sense be considered the best obtainable. Their use in any yard may be considered a short cut to better but not best results, and as such are worthy of consideration from a competitive viewpoint.

Use of Data

Referring to Fig. 1, which, it should be remembered, applies to a particular yard building a certain type of cargo ship, the "cost line" is plotted from known conditions, as indicated under "Data used." Reference to the paper "Steel Ship Construction from a Management Viewpoint" and Standard Practice Bulletin No. 17, published by the Fleet Corporation under the direction of the writer, will reveal the fact that the average production of a number of yards for nine months of 1918 was 35 equivalent deadweight tons* per man per year and that the best of these yards showed an average of 45 equivalent deadweight tons per man per year. The average production of sixty-seven yards, that being the total number building steel ships, was a trifle better than 19 equivalent deadweight tons per man per year. Obviously, it would not be reasonable to set up any of these averages as a standard for any particular yard unless something were known of the conditions at that yard. On the other hand, if conditions were known or could be developed by investigation, steps could be taken to establish a tentative standard that would be workable through plotting the yard's cost line.

Tentative Standards

In the case in point the production, based on results obtained for September, October and November of 1919, indicated very clearly what could be expected under normal operating conditions with certain faults corrected. The existence of these faults, by the way, was recognized by the management, and they are now being remedied through expert advice and assistance. Taking it for granted that the remedy will produce the expected results, there was no hesitation in arriving at a tentative standard of 27 deadweight tons per man per year. Having arrived at this conclusion it is a simple matter of calculation to set overall standards for fabricating, erecting and riveting, and from these in turn set up gang or machine or man standards. This done, the means are at hand for referring daily performance to standard performance in any one of several ways. The writer prefers graphs, rather than records, as they tell the story at a glance. The records are available, if needed, to investigate any particular occurrence.

Minimum Cost Line

Fig. 2 is the same yard with the graph worked out to fulfill certain assumed standards and to develop a "minimum cost line." The number of men employed is determined by standards required and the fabricating capacity is supposed to vary with the building programme. The "cost line" from Fig. 1, transferred to this graph, is illuminating in many ways, but principally as showing the difference between what is and what might be, if all the elements of this particular yard were properly adjusted. Fig. 2 is, of course, only practical within certain well-defined limits, such, for instance, as erecting no more steel than it is possible to handle with efficient crane service or keeping the equipment of the fabricating shops from being excessive. Within its limits, however, it can be used to good advantage to determine ultimate standards. By plotting actual cost lines thereon from time to time, some idea of the yard's progress toward perfection may be gained. As stated in reference to Fig. 1, please bear in mind that Fig. 2 is also for a particular yard building a certain type of ship.

Fig. 3 is a graph showing the number of men per way (direct labor) at different man efficiencies and building programmes. It is useful for the purpose of indicating the reduction in time and cost due to increased man efficiency and pointing to the necessity of making every effort to increase this efficiency. In the particular case under discussion there is a variation in building time of over

* Equivalent deadweight tons means production in terms of a 7,500 deadweight ton cargo vessel. This was the method used by the Fleet Corporation to reduce output of different yards to a common basis. In the case of a 9,000 deadweight ton vessel, 45 equivalent deadweight tons is equal to 50 actual deadweight tons.

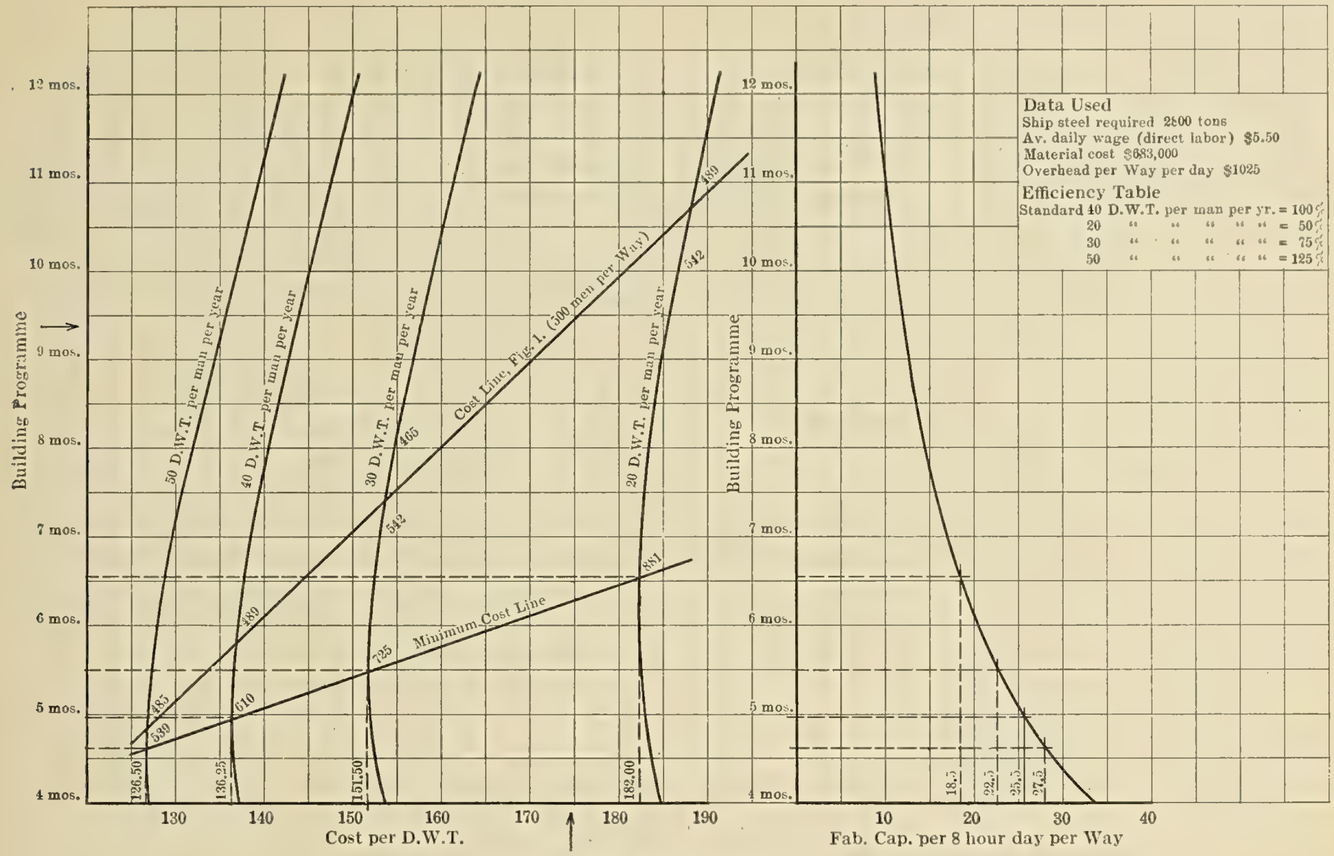


Fig. 2.—Chart on Which Minimum Cost Line Is Developed

three months between man efficiencies of 20 deadweight tons and 30 deadweight tons per man per year. Reference to Fig. 2 will show the difference in cost to be a trifle over $29 per deadweight ton. With such results well within the bounds of practical accomplishment, is it not ordinary business acumen for executives to be in possession of such information?

In other words, why not make, or have made, an "engi-

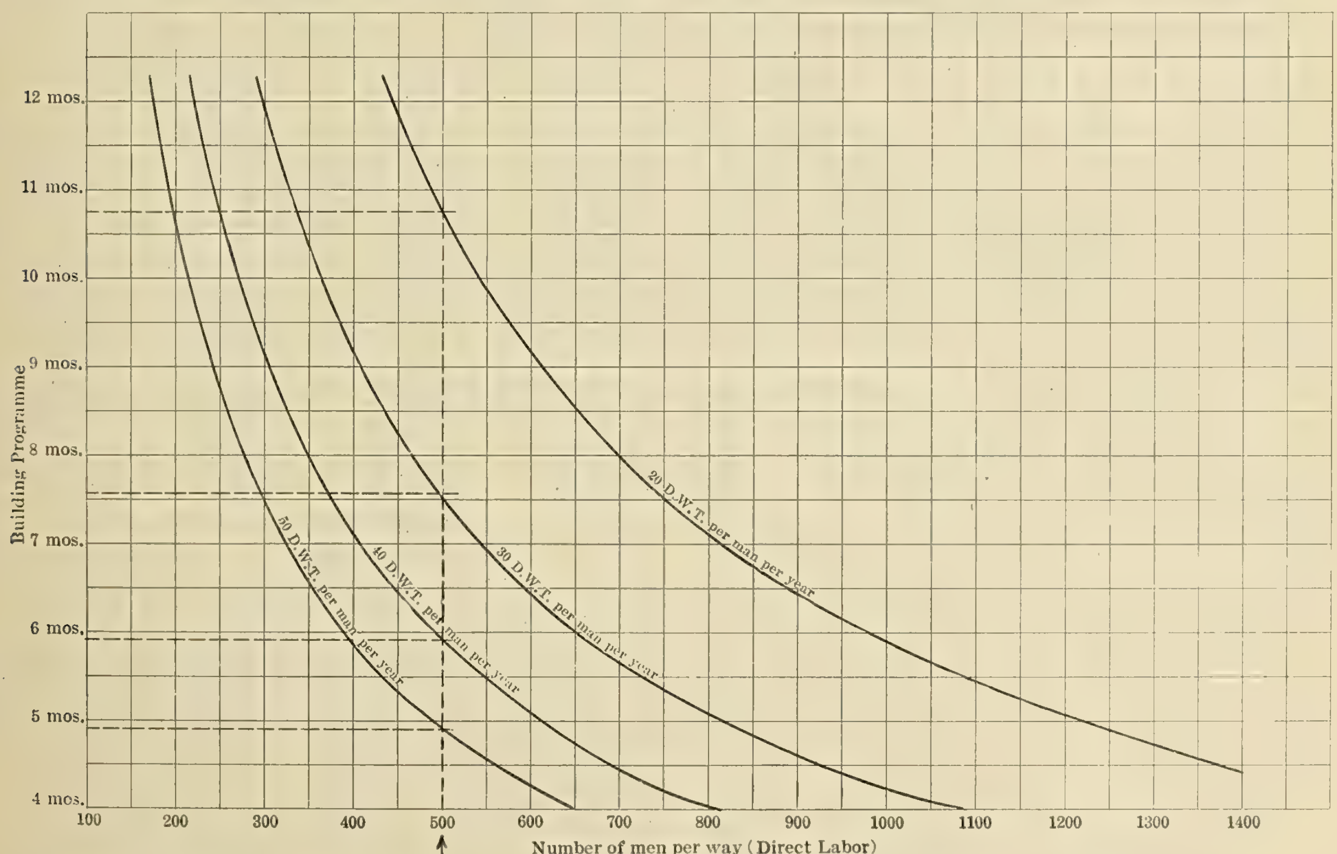


Fig. 3.—Chart Showing Number of Men per Way (Direct Labor) at Different Man Efficiencies and Building Programmes

neering appraisal" to determine existing conditions and utilize the knowledge thus obtained to set up standards for the purpose of more economical construction and greater profits? The yards that do this will certainly be in a position to enter the competitive field knowing their limitations, and therefore will be less liable to enter into losing contracts. On the other hand, such an "engineering appraisal" will show conclusively that certain results can be predetermined, which is far more safe and satisfactory than depending on what is or might be accomplished at some future date. It is the difference between knowing certain things with reasonable accuracy before the event and taking a chance that they will come out as desired, which is but another way of saying that it is better to work to standards suited to actual conditions than to attempt to get results that a careful investigation would show to be next to impossible.

For example, referring to Fig. 2, it will be seen that at 20 deadweight tons per man per year the most economical cost per deadweight ton is $182 with a building programme of 6½ months. To accomplish this will require 881 men per way. With 500 men per way at the same rate of output the cost per deadweight ton will be $188.25 with a building programme of 10¾ months. Knowing this, the shipbuilder would be able to offer delivery with reasonable assurance of avoiding penalties, whereas without such knowledge he might be influenced to offer shorter delivery in order to secure the business and take a chance on the penalties.

Results of an "Engineering Appraisal"

Supposing this was actually done, he is asking his yard to show results that it has never accomplished. On the other hand, with graphs before him, as a result of an "engineering appraisal," he would know at a glance that in order to make the promised delivery he would have either to put on more men or to bring up the output per man of his present force. Presumably he would know which of these two courses to take, but without the graphs before him he might easily take the wrong course, with more or less disastrous results.

Assume, for the sake of argument, that without the graphs he decided to put on more men, which is what the ordinary executive will do to increase output. He would not know where to stop until the records came in showing desired results. With the graphs before him, however, he could see at a glance, Fig. 3, that if he can maintain an output of 20 deadweight tons per man per year and wants to make delivery in 9 months, he would have to put on 610 men per way, an increase of 110 men per way over his regular force of 500.

On the other hand, assume he decided to force the output with the original force, without the graphs to guide him. As construction progresses he is taking long chances and perhaps losing valuable time unless the driving methods are successful. Supposing they are not, he will soon reach the point where he will have to put on more men or work overtime. In other words, he is compelled to change his original plan and resort to one forced upon him to prevent or minimize a loss. By his own acts he creates an emergency, whereas a complete and thorough knowledge of all the contributing factors of the industry, as developed by the particular form of appraisal advocated, would, to say the least, tend to minimize the chances of such a condition.

The writer especially wishes to impress upon the readers of MARINE ENGINEERING, and upon shipyard executives particularly, that what he advocates is not theory in any sense of the word. It is simply applying methods used with more than a fair degree of success in other industries to that of shipbuilding. It is a development of the generally accepted idea of some years' standing that management in industry has well-defined responsibilities and that labor alone is not wholly chargeable with everything that goes wrong. It would be utterly foolish, if not impossible, to install boiler and engine foundations in a ship without working up the details from the boiler and engine drawings. By the same method of reasoning, why should not a knowledge of all the details of an industry be of value when the data are available to work them up?

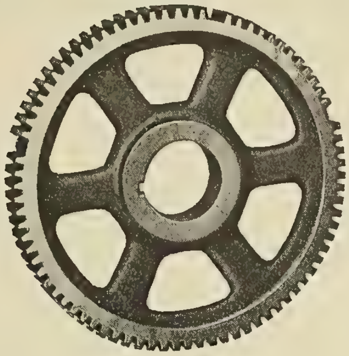
Basis of True Standards

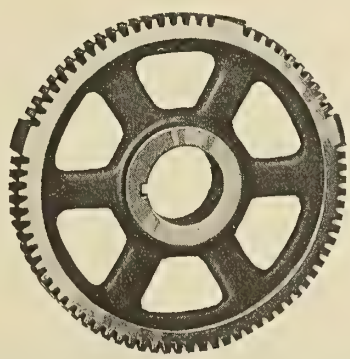
Progressive executives of today are a unit in supporting the principle of working to standards, provided they are set up as a result of proper study and investigation. False standards or those established on incomplete information usually do more harm than good and those set up by averaging past performance are misleading, to say the least. The former are more or less guesswork, and the latter are not really standards at all, although they serve the purpose of predetermining costs at that rate of output and under certain given conditions. A real standard implies results under most favorable conditions; consequently, conditions should be the first point of attack. When they are adjusted satisfactorily, then, and then only, can data be secured on which to base working standards that will mean anything. As a matter of fact, the adjustment of conditions to the most satisfactory point is by far the largest and most important factor in the work of developing standards. It frequently happens that it is necessary to make radical changes in the organization of an industry before conditions can be made the most satisfactory.

The usual method of arriving at standards has been to follow certain well-known principles of management involving the introduction of systems of production and material control, and after these have become well established to set about securing information on which to base standards. There can be no possible objection to this method, provided sufficient time is allowed properly to introduce the new systems without disrupting the organization and thereby affecting production. Assuming that ample time has been given, the result is that ultimate standards are set up which represent perfection in a practical sense. It so happens that many executives do not have the patience to permit the work to be carried out along these lines, believing that quicker results should be obtained, or, at least, that the way to improvement should be clearly enough indicated as the work progresses to enable them to take current advantage of it. In this they are perfectly correct and almost immediate results can be accomplished by the method of tentative standards developed by the writer and applied in several cases in the shipbuilding industry.

What Standards Indicate

The method involves an "engineering appraisal," which is an analysis of records and more or less investigation to show just *what is being done* and then working from this to indicate *what should be done*. Please note that the word "indicate" is used advisedly, for the reason that what should be done is not necessarily what can be done. The idea is to set up empirical standards to show what might be possible in the way of improvement by comparison with what is being done. These empirical standards are determined in consultation with the management. In the process of analyzing records accompanied by original in-





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vestigations primary faults are sure to be brought to light and open the way for immediate corrective measures. By using judgment as to the effect of these corrective measures tentative standards can be set up which immediately give the organization a mark to shoot at. The refinement of the corrective measures can then be worked out more in detail, and, after having been in effect for a reasonable length of time, ultimate standards can be set from which future work can be estimated.

This method of tentative standards is unusual in that it primarily shows the necessity for improvement by comparing what is with what should be. It also is unusual in that it works from the top down instead of from the bottom up. In other words, the output in finished product is the starting point rather than the individual parts. Knowing the required output, it is a comparatively simple matter to set standards for the parts, keeping in mind the necessity for most favorable conditions when ultimate standards are set.

As a direct result of the war, the shipbuilding industry in this country has expanded enormously, as evidenced by the fact that the number of men employed increased from 50,000 to over 350,000. The question is often asked: "What is to be the final outcome?" It is not believed possible to answer that question at the present time, though it is generally conceded that the survival of the fittest will play a most important part.

Eventually the industry will settle down to a basis regulated by the law of supply and demand, and when that time comes the weak sisters will be crowded out. In the meantime there is enough business in sight to replace tonnage lost during the war to absorb the world's output provided prices are reasonable. This state of affairs may last for two years or more, so that opportunity is at hand for the shipbuilder to put his house in order. Will he take it and be reasonably assured of survival or will he allow it to pass and fight against the inevitable and finally be compelled to acknowledge defeat?

In both Figs. 1 and 2, attention is called to the wide variations in deadweight ton costs. As similar conditions apply to many shipyards, is it not worth while for executives to give this subject the most serious consideration? Foreign competition has not yet developed its full effect, so the time to do this is now, and not after organizations are adversely affected through idle ways due to loss of business either at home or abroad.

An Analysis of the Isherwood System*

Transverse Stresses and Diagonal Distortion—Failure of Bottom Through Collapsing—Strength of Decks—Miscellaneous Stresses

BY JOHN FLODIN, M. E.

Although not as important as the longitudinal stresses, the transverse stresses a vessel is subjected to are often quite severe, and it is consequently essential that a change in the system of construction does not unduly weaken the vessel transversely any more than a weakening longitudinal would be permitted. For example, if data based on long experience seem to indicate that a certain bilge connection furnishes but a reasonable margin of strength, we cannot arbitrarily substitute another connection of less strength without adequately compensating for the loss. By doing so we should expose the vessel to serious straining when, especially if heavily loaded, it encounters a seaway. Immediate failure would perhaps not result, but the riveting would gradually give way, and troublesome leaks would develop.

Failures due to the three principal transverse stresses are indicated in Figs. 5 to 9, inclusive.†

Diagonal Distortion

A distortion of the hull in the manner and because of the stresses indicated in Figs. 5 and 6 would evidently mean a failure of the transverse framing in the vicinity of the bilge, at or near the connection at the second deck to the side of the ship, and possibly, but not necessarily, at or near the connection of the upper deck to the side of the ship. Considering these in the order named, first for the transverse vessel and then for the Isherwood vessel, we have:

The Bilge Connection.—From an inspection of the midship section we can conclude that the weakest point in the bilge connection is either through the riveting connecting the side frame to the bilge bracket, or through the frame itself, in line with two of the connecting rivets, as indicated by the dot-and-dash line in Fig. 10. The failure of the framing would in either case be accompanied by a failure of the shell plating, so that we should include, as contributing to the strength of the framing, a strip of the shell plating equal in width (i. e., in the longitudinal direction) to two and one-half times the width of the shell flange of the frame bar, reduced by one-half the diameter of the shell rivet in order to obtain a result that will represent a mean between tension and compression conditions.

To determine the strength of the riveted connection, the polar moment of inertia about the center of strength of the section must be found. This is most conveniently done by first finding the center of gravity of the connection and then calculating the moments of inertia about vertical and horizontal axes through the center of gravity. The sum of these two moments of inertia equals the desired value of the polar moment of inertia.

Taking the shearing strength of the rivets as equal to the tensile and compressive strength of the steel, the moment of inertia about the horizontal axis is found to be 577.5 inches^4, and about the vertical axis 157.5 inches^4, from which the polar moment of inertia equals 735 inches^4. If we regard the distance of the center of the farthest rivet from the center of gravity of the connection (or, more correctly, the center of strength) as the distance to the extreme fiber, the polar section modulus equals $735 \div 13.13 = 55.98$ inches^3.

The moment of inertia of the side frame, deducting for the rivet holes, equals 186.86 inches^4, and the section modulus equals 25.5 inches^3.

The Second Deck Connection.—Four possible modes of failure present themselves at the juncture of the second

* Concluded from the February issue.
† These sketches are borrowed from Holms' Practical Shipbuilding.

deck beam to the frame. The beam bracket may be ruptured as shown in Fig. 5 (see also Fig. 12); the frame may fail at the toe of the bracket; the riveting of the bracket to the frame or to the beam may fail; or, finally, the beam may fail at the inboard toe of the bracket. It is very evident, however, that the bracket plate is con-

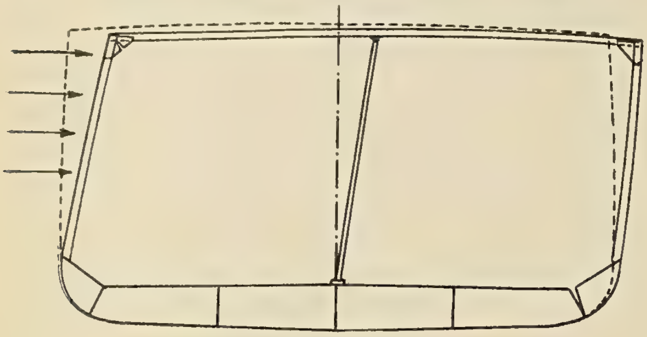


Fig. 5

siderably stronger than the rivets connecting it to the beam or to the frame, so that the first-mentioned possibility may at once be discarded. Furthermore, the section modulus of the side frame, without correcting for the riveting or for the strip of shell plating contributing to the strength of the frame, is 21.9 inches^3, as compared to the section modulus of 12.7 inches^3 for the deck beam channel, so that the possibility of failure of the side frame at the toe of the beam bracket may also be abandoned.

For the strength of the bracket riveting, considering the rivets in one arm of the bracket only, we may divide the sum of the second moments of the rivets about the center

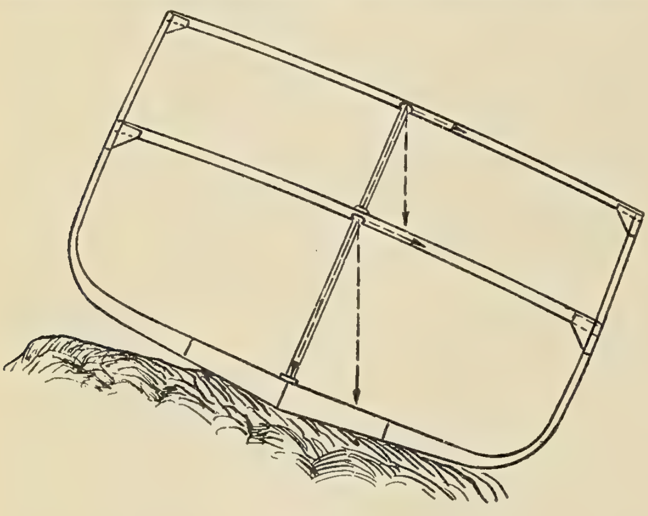


Fig. 6

of the rivet nearest the heel by the distance to the toe rivet. The section modulus thus obtained is 26.02 inches^3. Calculating the strength of the deck beam at the toe of the bracket, including again a strip of plating, we find that the section modulus is 16.1 inches^3.

The Upper Deck Connection.—Applying the same reasoning to the upper deck connection (see Fig. 13), we find the section moduli for the riveting and for the deck beam at the toe of the bracket to be 18.61 inches^3 and 13.2 inches^3 respectively.

The Combined Strength.—As a representation of the ability of the hull to resist forces tending to cause diagonal distortion, we may, then, take the sum of the least section moduli at each connection, or, excluding the upper deck, $(25.5 + 16.1) \times 2 = 83.2$ inches^3, and, including the upper deck, $83.2 + 2 \times 13.2 = 109.6$ inches^3, the factor of two being introduced by the fact that failure cannot occur at one side of the vessel alone.

The corresponding values per foot length of the vessel are 38.4 inches^3 and 50.5 inches^3, the frame spacing being 2 feet 2 inches between peak bulkheads.

Diagonal Strength of the Isherwood Ship.—The corre-

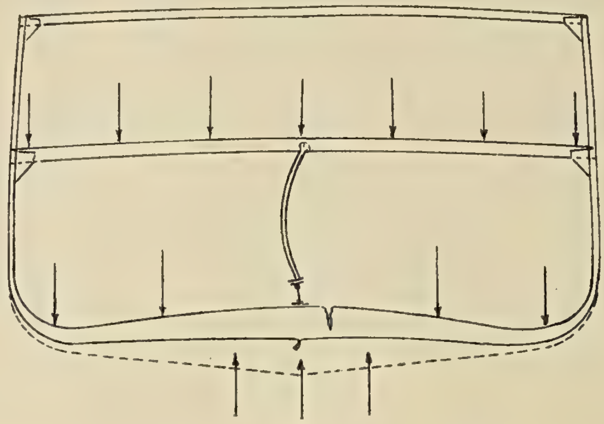


Fig. 7

sponding probable points of failure in the Isherwood vessel are:

At the bilge connection:	At longitudinal No. 14.
At the second deck:	At the second longitudinal from the side of the vessel.
At the upper deck:	At the second longitudinal from the side of the vessel.

These points of failure, while they are taken at the points of least section moduli, are somewhat further re-

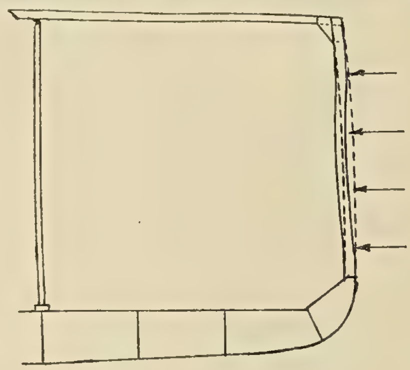


Fig. 8

moved from the theoretical points of failure than were the corresponding points in the transversely framed vessel, thus introducing the factor of a lever arm. It is impossible to express this difference mathematically, if, indeed, such an expression should be desired, and consequently the difference has been omitted in these calculations. It should be remembered, however, that this omis-

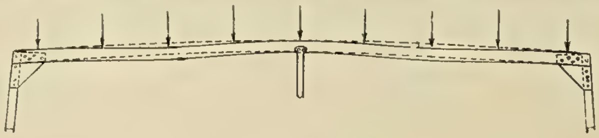


Fig. 9

sion makes the exactness of the conclusions somewhat doubtful, the doubt being in favor of the Isherwood ship.

Calculating the strength at the points indicated above, using the same reasoning as for the transversely framed vessel, but including as part of the transverse at longitudinal No. 14 a strip of the shell plating equal in width to only one and one-half times the combined width of the

shell clip flanges, since a double angle connection is here used, we have, for the bilge connection, a section modulus of 241.0 inches³, for the second deck connection a section modulus of 41.7 inches³, or a total of 565.4 inches³ for both sides.

The modulus for the upper deck connection is 47.5 inches³, giving a total of 660.4 inches³ for both sides of the entire section. The transverse spacing being 12 feet (except in the peaks and forward of the three-fifths length), the combined section modulus per foot length of the ship becomes 47.1 inches³ excluding the upper deck, and 55 inches³ including the upper deck.

Summary.—For more ready comparison we may summarize these section moduli as follows, the values being given in inches³ for both sides of the vessel:

Connection	Transverse Framing Per Frame Space	Transverse Framing Per Foot of Ship	Longitudinal Framing Per Frame Space	Longitudinal Framing Per Foot of Ship
At the bilge......	51.00	23.55	482.0	40.17
At the second deck.	32.20	14.85	83.4	6.95
At the upper deck.	26.40	12.20	95.0	7.92
Totals	109.60	50.60	660.4	55.04

It will be noted that the Isherwood vessel compares very favorably with the transversely framed ship as far as the total resistance to diagonal distortion is concerned. The Isherwood bilge connection develops 70.6 percent more strength than the corresponding connection in the older system of framing, while the Isherwood deck connections are weaker. And it may be argued that this is a more favorable distribution of strength, since the bilge connection is continuously subjected to severe stresses due to the water head. There is unquestionably some justification for this viewpoint, provided that the deck connections are not weakened to such an extent as to make the decks themselves unsafe. This question will, however, be considered separately under the head of "Strength of Decks."

Failure of Bottom of Ship Through Collapsing

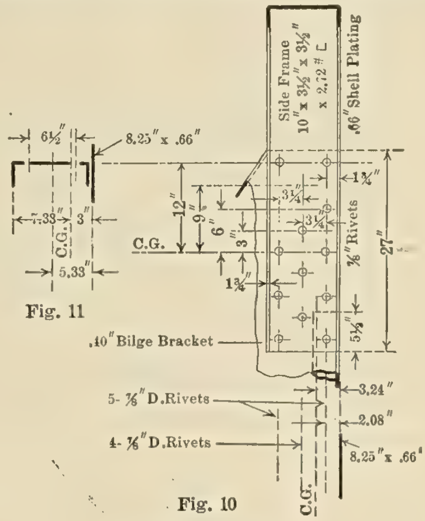
In the case of a failure of the type shown by Fig. 7, which might occur when the weight of the vessel is resting on keel blocks along the centerline, or on the ground, as in the case of stranding, a considerable discrepancy exists between the transversely and longitudinally framed vessels. In the former we have two rows of pillars, giving a transverse span of 21 feet between the pillars, while in the latter case there is but a single row of pillars along the centerline of the vessel. In the former vessel the stressing of the bottom to failure through collapsing would then mean the failure of the floors at or near the centerline, while in the latter the most dangerous point of loading would be at some point about halfway between the centerline and the support at the margin, and the failure would then occur near the point of loading.

For the transversely framed vessel we find the section modulus to be 243.8 inches³ for the floor connection at the centerline (the line of fracture is supposed to pass through the riveting of the floor clips to the center vertical keel, past the top and bottom horizontal keel angles, and through the flat keel and rider plates) and 283.3 inches³ for the floor through the first lightening hole from the centerline of the ship. In each case a strip of the shell plating equal to two and one-half times the horizontal flange of the connecting angle is included, and also a strip of the tank top plating of similar width less one rivet diameter, the tank top plating being in tension, while the shell plating is in compression.

The least section modulus is, then, 112.2 inches³ per foot length of the ship. Regarding the floor as an encastre beam* and taking the allowable fiber stress as 16,000 pounds per square inch, we may find the safe concentrated load by the formula:

$$M = \frac{Pl}{8},$$

where M is the bending moment in inch-pounds, P is the load in pounds, and l is the length of the span in inches.

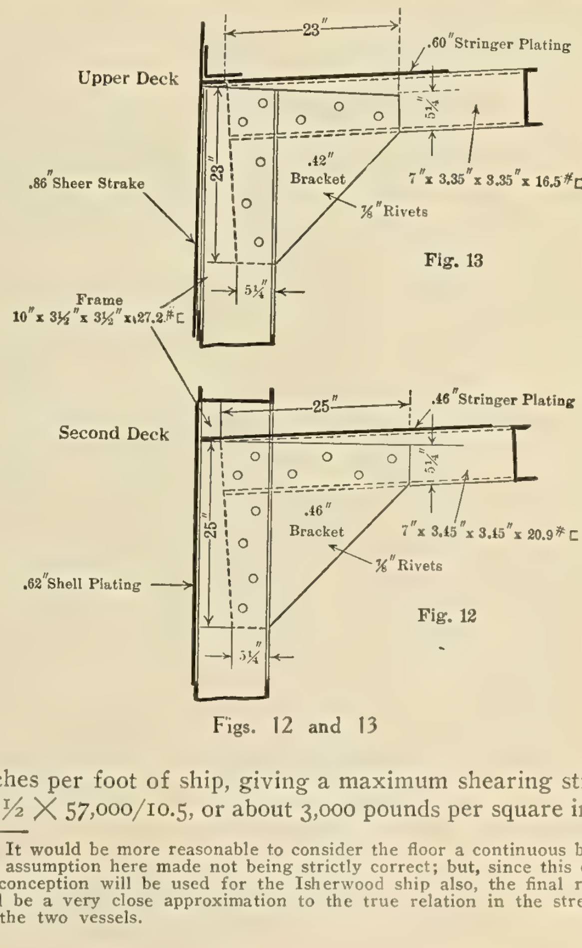


Figs. 10 and 11

Equating this to the resisting moment, we have:

$$P = \frac{16{,}000 \times 112.2 \times 8}{20 \times 12} = 57{,}000 \text{ pounds per foot of ship.}$$

The area of a floor section through a lightening hole near the pillar is 22.69 square inches, or about 10.5 square inches per foot of ship, giving a maximum shearing stress of ½ × 57,000/10.5, or about 3,000 pounds per square inch.



Figs. 12 and 13

* It would be more reasonable to consider the floor a continuous beam, the assumption here made not being strictly correct; but, since this error of conception will be used for the Isherwood ship also, the final result will be a very close approximation to the true relation in the strength of the two vessels.

In the Isherwood ship the failure would undoubtedly occur through a lightening hole, the line of fracture passing through the notches for both the tank top and bottom shell longitudinals. The modulus for this section is 303.2 inches³ for each transverse floor and for the intermediate floors, or 50.5 inches³ per foot of ship.

Regarding the floor again as an encastre beam, whose span in this case is 20 feet (allowing a reasonable overlap with the side transverse bracket), we have:

$$P = \frac{16{,}000 \times 50.5 \times 8}{20 \times 12} = 26{,}900 \text{ pounds per foot of ship.}$$

It will be seen that the strength of the Isherwood ship falls far short of the strength of the transversely framed one as far as the collapsing of the bottom is concerned. It should be noted, however, that the centerline arrangement of the pillars in the Isherwood ship gives that ship an advantage when resting on keel blocks. But this pillar arrangement is not a characteristic of Isherwood ships in general, since many of them have two rows of pillars, and would then show a weakness as compared with the transverse construction that is roughly represented by the results obtained above. In either case this strength represents resistance against extraordinary external forces and is not to be regarded as representing conditions met with in ordinary service. The stress on the bottom of the ship, using the load draft of 23 feet 6 inches, but not making any allowance for the balancing effect of the cargo, would set up a fiber stress of about 5,800 pounds per square inch in the floor of the Isherwood ship, showing that for sea conditions the Isherwood construction furnishes a large margin of strength.

It should further be remarked that Lloyd's rules permit the omission, in transversely framed vessels, of alternate floor plates, except forward of the three-fifths length and under the engines and boilers, at which parts Isherwood vessels have additional floors. In cases where alternate floor plates are omitted, only the bottom frame bars and the reverse frames are fitted, and even the reverse frames may, under certain conditions, be omitted. A vessel so constructed would show very nearly the same strength of bottom as the Isherwood vessel, namely, a maximum safe load of 28,500 pounds and 26,900 pounds for the two types respectively per foot length of ship.

In view of the above figures it may, then, be said that even though the Isherwood vessel does not possess the same strength of bottom per foot length of ship as a transversely framed vessel of the same size and type, built with floors at every frame, the strength developed by the Isherwood construction is ample, and the construction is consequently more logical.

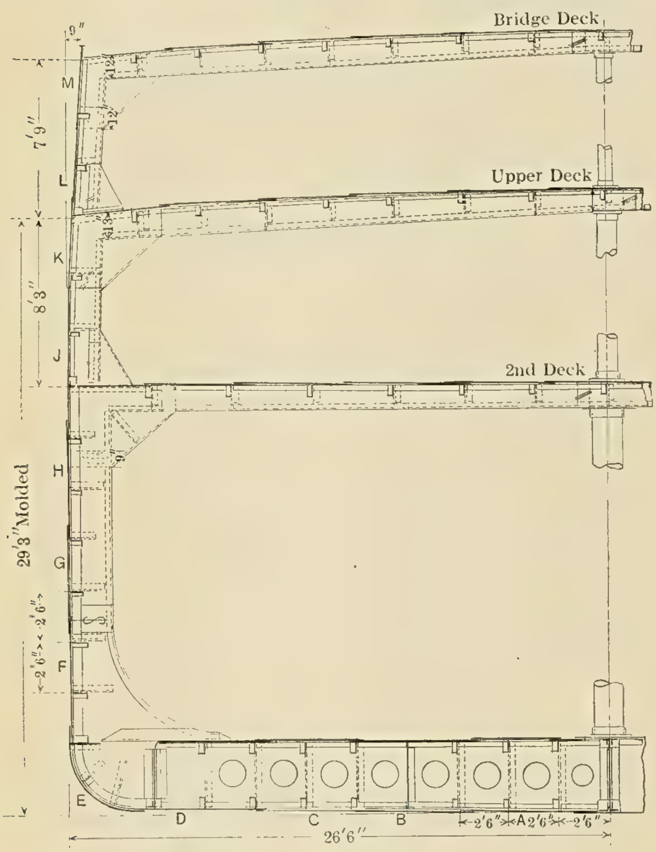


Fig. 14.—Midship Section of Isherwood Framed Ship

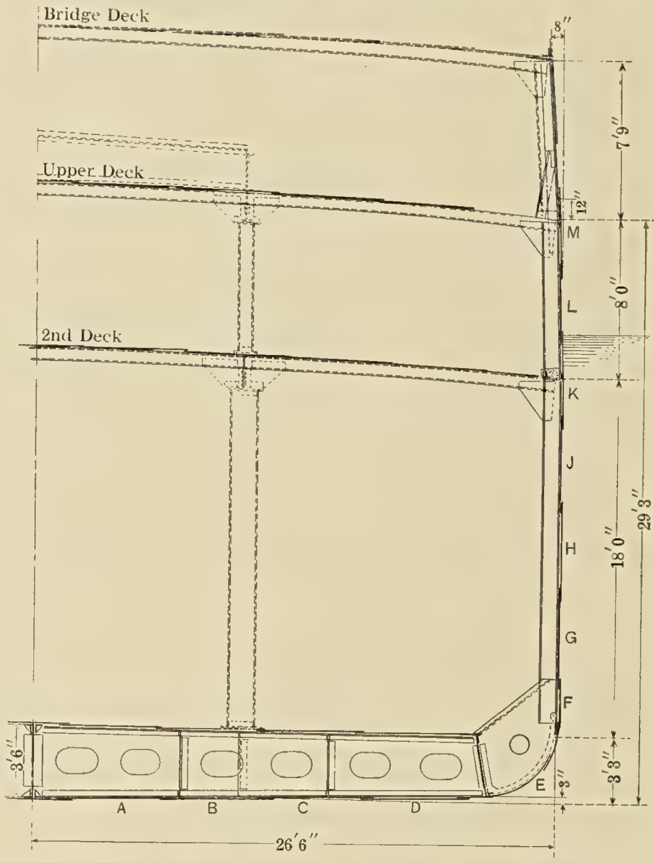


Fig. 15.—Midship Section of Transverse Framed Ship

The Shell Plating

On the midship sections (Figs. 14 and 15) the shell plating is seen to be lighter for the Isherwood vessel. The fact is, however, that the thickness of the shell plating of the Isherwood vessel is in accordance with Lloyd's rules, regardless of the change in the system of construction, while the shell plating of the transversely framed vessel was increased in thickness to compensate for the omission of the side stringers. Hence no comparison of the strength of the shells need be made, except in so far as they enter into the longitudinal strength of the ships.

Collapsing of the Side Framing

In connection with the analysis of the resistance of the two vessels to diagonal distortion, it was shown that the strength of the Isherwood transverses at longitudinal No. 14 is represented by 40.17 per foot of length of vessel, as compared to 23.55 for the strength of the side

frame of the transversely framed vessel at the top of the bilge bracket. The Isherwood transverse at the point considered is about one inch deeper than it is at the longitudinal next above, so that the strength ratio of 70.6 percent, in favor of the Isherwood vessel, does not quite apply to the strength of the side framing. But, owing to the great excess in strength of the Isherwood transverse, we need have no hesitancy in saying that there is a considerable margin of strength of side framing in favor of the longitudinally framed ship—a margin of, perhaps, about 68 percent.

Strength of Decks

As in the case of the strength of the floors, the difference in the pillar arrangement introduces a considerable discrepancy in the deck strength of the transversely and longitudinally framed vessels. In the transversely framed vessel the strength of the decks is obviously dependent on the strength of the deck beams and on the maximum span, which is again the distance between the pillars, or 21 feet. Including, as before, a strip of the deck plating as contributing to the strength of the beam, the section moduli of the deck beams are found to be 12.61 inches^3 for the upper and 15.2 inches^3 for the second deck beam, or, per foot of ship, 5.81 inches^3 and 7.01 inches^3, respectively. Using a fiber stress of 16,000 pounds per square inch and applying the formula for uniformly loaded encastre beams, the upper deck beams are found capable of supporting 8,860 pounds per foot length of ship, or 423 pounds per square foot of deck area (a rather high value, since it corresponds to a 6.75-foot head of water—more than twice the height of the bulwarks—or a 10-foot deck load of lumber), while the safe load for the second deck is 10,700 pounds per foot length of ship, or about 510 pounds per square foot of deck area (again a rather excessive value, since it would allow the carrying of a homogeneus cargo weighing 64.5 pounds per cubic foot, a figure considerably above what the buoyancy of the vessel could support).

It will be noted that the weakest part of the decks of the transversely framed vessel is between the pillars, that is, between the hatches. In the Isherwood ship the load on the decks between the hatches is supported by the deck longitudinals, from which the stresses are transmitted to the bulkhead at the middle of the longitudinal span between the hatches and to the hatch end transverses at the ends of that span. Calculations similar to those made for the decks of the transversely framed vessel show that the deck longitudinals are capable of supporting loads of 2,290 pounds and 3,310 pounds per foot length for the upper and second decks respectively. Because of the variations in the spacing of the longitudinals, this means that the maximum safe load for the upper deck is 665 pounds per square foot between the hatches and 723 pounds per square foot between the hatch-end transverses outboard of the fore-and-aft hatch coamings, while the second deck could carry a load of 945 pounds per square foot between hatches and 830 pounds per square foot in the wings.

This, however, does not take care of the strength of the decks at the wings along the sides of the hatches. Here the loads on the longitudinals are transmitted to the half-transverses that furnish the intermediate reactions. These half-transverses have section moduli of 36.55 inches^3 and 34.3 inches^3 for the upper and second decks respectively. Assuming that the decks are uniformly loaded up to the smaller maximum capacity found above for the space between the hatch-end transverses, and that the load is concentrated at the points of support of the longitudinals, we can proceed to determine the fiber stresses. In either deck the extreme outboard longitudinal is directly supported by the transverse deck bracket, so that the loads borne by that longitudinal and directly by the shell connection do not add to the bending moment. For the rest of the transverse beam the bending moments are approximately 500,000 and 520,000 inch-pounds, giving fiber stresses of 13,600 and 15,200 pounds per square inch in the upper and second deck half-transverses respectively.

The inboard ends of these half-transverses are supported by the fore-and-aft hatch coamings, which in the Isherwood ship are somewhat stronger than in the transverse vessel. The reactions of the fore-and-aft hatch coamings are in turn borne by the hatch end transverses, which also receive the actions from the ends of the longitudinals between hatches and outboard of the fore-and-aft coamings, the last loads being similar to those borne by the half transverses. These hatch-end transverses are heavily built and are reinforced by a 10-inch by 1.0-inch face plate for the second deck, and a 10-inch by 0.70-inch face plate for the upper deck, although these are not shown on the midship section (Fig. 15). The loads are heavy, however, and the fiber stress at either deck is somewhat in excess of 40,000 pounds per square inch. Since the bending moment, and hence the fiber stress, are diectly proportional to the loads, we may conclude that the safe loads found above are about two and one-half times too great. The deck loads for the Isherwood vessel should, then, be about 280 pounds per square foot for the upper deck and 330 pounds per square foot for the second deck, as compared to the corresponding values for the transversely framed vessel of 423 pounds and 510 pounds per square foot.

Apparently, then, there is a loss in the strength of the decks amounting to nearly 34 percent for the upper deck and 35 percent for the second deck.

It was pointed out, in connection with the strength of the decks of the transversely framed vessel, that a large margin of strength existed. Some reduction could consequently be approved of, but it seems that it would be more advisable to increase the strength of the hatch-end transverses and reduce the surplus strength of the deck longitudinals, especially so since the fiber stresses due to longitudinal bending of the ship as a unit are unduly small. This is, however, a question pertaining to the particular design under consideration rather than to the principles of the Isherwood system of construction.

Miscellaneous Stresses

Torsion.—The question of torsional strength would probably have escaped attention had it not been for the fact that the inquiries, which will be referred to later, elicited the information from a European shipping firm, who request that their name be not used in connection with the statements they make, to the effect that the two Isherwood ships they own and operate showed a torsional weakness. To quote their letter in free translation: "The ships seemed to be looser, allowing an undue amount of twisting. This made it necessary to stiffen them by means of additional bracketing, which successfully overcame the difficulty, but which also partly wiped out the saving of weight above referred to. But, as already mentioned, these were some of the first longitudinally framed ships ever built, and we understand that the later vessels of this kind are proving very satisfactory. * * *"

Since the torsional strength of any body is proportional to the polar section modulus, and since it is evident that the increased number and areas of the longitudinal members in the Isherwood ship mean an increase in the polar section modulus (cf. the section moduli for horizontal axes), it is rather difficult to understand how an Isherwood

ship can allow "an undue amount of twisting." The only explanation that presents itself is that the shell and deck longitudinals were not properly connected where they were cut at the watertight bulkheads, a suggestion that appears to be a probability when it is remembered that additional bracketing successfully overcame the difficulty. But even if the bracketing were originally faulty, the shell and deck plating should have remained intact, giving these vessels practically the same polar section modulus as they would have had if they had been built to the transverse system, and they should consequently not have shown any torsional weakness.

It is not impossible, however, that the question of torsion is not fully understood; it may be that the transverse stiffening of a hollow body has an effect on the torsional strength that is not represented in the polar section modulus, but it seems probable that this effect, if it does exist, would be slight. It appears, then, very unlikely that a properly designed and constructed Isherwood ship should be weaker in torsion than a transversely framed vessel of the same type and dimensions.

Stresses Due to Vibration.—It is contended, and is probably true, that vibration is less in Isherwood ships than in transversely framed ships. But it should be remembered that the question of vibration becomes serious only when there is synchronism between the vibration period of the hull, the vibration period of the machinery, or the vibration period of liquids in tanks or liquid cargo, or between all three periods. Enough work has not been done in this field to make it possible to predetermine any one of these three vibration periods, except in so far as reciprocating machinery may be regarded to be likely to vibrate in synchronism with the period of the stroke, and it consequently seems decidedly advantageous to reduce the amplitude of the vibrations wherever that is possible.

Practical Considerations and Opinions of Shipbuilders and Shipowners

Among the advantages claimed by the Isherwood supporters are that the ships built to this system are more easily cleaned and repaired, and that the ventilation is improved.

It is unquestionably true that the Isherwood ships are more easily cleaned and painted, especially so in the double bottom. With the floors spaced 24 to 30 inches apart, as is usually the case in transversely framed ships, the cleaning and painting of the spaces between the floors become both an expensive and unpleasant task, whereas with the floors spaced from 5 to 6 feet apart, as is the practice in Isherwood ships abaft the three-fifths length, there is ample space and better air for the men to work in.

It is not so easy, however, to draw a conclusion as to the ease of repairing the vessel. This is a point on which the results of years of experience alone can throw light. This is also true of the question of ventilation.

In order to obtain information on these points, as well as general expressions of opinions and criticisms, inquiries were sent out both to shipowners who were or had been operating Isherwood ships and to shipbuilders who had had extensive experience in this field of work. In all, forty-eight letters of inquiry were sent out, the field covered including, besides American firms, several European countries, Australia and China. The results were, unfortunately, not very satisfactory. Many of the inquiries, or the letters sent in answer to them, were perhaps lost or miscarried because of the war-time irregularities in the mail service; and of the relatively few answers that were received, a considerable number were non-committal, or the writer had the impression that the Isherwood system had certain advantages, but admitted that he did not know this from his own experience. With but one exception, all the answers received were favorable to the Isherwood system.

The answers received from the naval architects connected with shipbuilding firms were uniformly in favor of the Isherwood system of construction, but it is not impossible that this favorable opinion was to some extent due to the greater ease and economy of fabrication and erection of the Isherwood ship.

The longitudinally framed vessel contains more bracket and small fitting work than the transversely framed one, but this item is more than offset by the lesser amount of furnacing of shapes. In erecting, the Isherwood ship offers two distinct advantages that tend to increase both the speed and economy of construction. One of these has already been mentioned in connection with cleaning and painting, namely, the greater accessibility to the various parts of the vessel, an item that seems even more important in erecting than in cleaning the ship. The second advantage is that the Isherwood ship can be erected in stories, as it were. That is to say, after the inner bottom has been completed, the side transverses up to the lowest deck may be erected, together with the transverses for that deck. All the material then taken on board, such as the deck longitudinals and plating, need be hoisted only high enough to clear the deck reached, not, as is the case with transversely framed vessels, high enough to clear the tops of the side frames, which, for the lowest deck, may mean a difference in the hoist of from 8 to 32—or more—feet, depending on the number of decks. This holds true for all decks except the highest one, although the height of the unnecessary hoist is, of course, reduced as the higher decks are reached.

To show what this apparently small item means to the shipbuilder, let us give a moment's thought to, let us say, a passenger ship of 20,000 tons displacement having four complete decks, the deck height being 8 feet in each case. This means a total height of 24 feet from the lowest to the highest deck, or an average hoist of 12 feet above the lowest deck level for all material for that deck and for the decks above. A total weight of perhaps about 1,000 tons would, then, have to be hoisted to an average greater height of 12 feet for the transversely framed vessel than would be necessary for the Isherwood ship, a difference of 12,000 foot-tons.

Conclusion

While the particular ship here used for purposes of analysis and comparison is not above criticism, it should be evident from the above that the Isherwood system of longitudinal framing offers many and important advantages, while the disadvantages seem to be relatively slight. Whether further development in shipbuilding will be along the lines of longitudinal or transverse framing, or a compromise between the two, is a question that the future alone can answer.

Wooden Sectional Floating Dry Docks

General Considerations Governing Choice of Commercial Dry Dock—Location and Cost—Design, Construction and Operation

BY CARL E. PETERSEN

AT the present time there are a very large number of wood sectional floating dry docks in use and under construction. It is the purpose of these notes to discuss some of the reasons for the adoption of this type as the most suitable from a commercial viewpoint.

Cost

The first consideration in the choice of a commercial dry dock is the first cost and the interest on the investment. Generally the first cost of a wooden sectional floating dock is less than that of the steel floating dock and the timber or concrete graving dock. In any comparison of costs of the various types, the cost of the dredging and mooring facilities required for the floating dock should be checked against the total cost of the other types.

A small concern commencing in business can first construct a sectional floating dock of a few sections and later increase the number of sections as the business warrants, provided, of course, that those first constructed are so designed as to take care of the expansion. This is a very desirable feature for those concerns which do not have sufficient capital to invest in a large dock. The returns from the investment can then be used to increase the size of the dock.

Another good feature of the floating dry dock is its mobility. Should business become bad at its present location it can be moved to another part of the port or to another port entirely. Also, a concern can more readily realize money on a dock of this type than on a graving dock.

Location

The proper location for any type of dry dock should be determined only after the most careful study of those factors which are necessary for commercial success. A poor location will greatly increase the cost of operation, although the dock itself may be well designed and constructed.

The principal factors to be considered in locating a dry dock are:

1. The proximity to manufacturing centers.
2. The proximity to terminal facilities.
3. The tide variation.
4. The currents.
5. The available depth of water.
6. The nature of the bottom.
7. The climate.

The proximity to manufacturing centers will influence the cost of those articles of manufacture which are needed in the repair of vessels, while the proximity to terminal facilities will determine the cost and time of shifting vessels to and from the dry dock and will also have a direct bearing on the shipment of ship material. It follows that a dry dock should be in close proximity to manufacturing and terminal facilities.

Generally efficient operation requires a small tide variation. If a floating dock is so designed that the available depth over the sill at low tides is such that it can dock a vessel equal to its capacity, there is no advantage in a large tide variation. The tide variation is also a factor in the choice of the type of dry dock most suitable.

A floating dry dock should be so situated as to be well clear of currents, if vessels are to enter and leave it with safety and ease. The best arrangement is to have the dock located inshore between two piers, the length of which should be approximately twice the overall length of the largest vessel that can be accommodated. When so arranged, while one vessel is on the dry dock the one next in turn is placed in the slip. The advantage of this is that the time of undocking one vessel and docking another is reduced to a minimum. The sides of the piers next to and in way of the dry docks should be sheathed with wood or steel piling to prevent silting, thus reducing the frequency of dredging under the dock to a minimum.

The depth of water available is a factor in the choice of the type of dock most suitable. Where the water is shallow, a graving dock would be more favorable. On the other hand, where deep water is available close to the shore, the choice would undoubtedly be for the floating dry dock.

Design and Construction

The basis for determining the dimensions of a sectional floating dry dock is the size and weight of the largest vessel intended to be docked. In other words, each section of the dock should have a lifting capacity at least equal to the weight of that portion of the vessel which is borne by the section. The members of the sections are largely determined empirically and from good practice.

Only first quality timber, well seasoned, should be used in the construction, and, as is the case with wooden ships, care should be taken to secure the best of fastenings. The extra expense of having only the best materials and workmanship is compensated with additional years of usefulness.

The pumps used should be of the vertical centrifugal type designed to operate efficiently under a variable head. They should be located low in the pontoons and be direct-connected by vertical shafting to electric motors situated on the decks of the wings. The motors should be connected to and operated from a central control station ashore. In these modern times there is no excuse for the inefficient steam-driven reciprocating pumps, so much used in the earlier dry docks. A small centrifugal pump, also electrically driven, should be provided in each side of each section for ordinary drainage, as it usually is uneconomical to operate the main pumps for this purpose.

The ordinary sectional dock was evolved in order to permit of self-docking; that is, the length of the sections is such that when any section is disconnected and turned at right angles it can be docked by another section. However, in designing, care should be taken to have a sufficient width between the wings at the keel block level, so that when a section is docked there will be ample clearance for workmen to effect any repairs necessary. In some of the docks built this clearance is so small that it is questionable if repairs could be made.

Operation

The time of construction of a wooden sectional floating dock is usually less than that required for other types. In fact, a floating dock may be built anywhere, and, if necessary, the sections may be built in different places.

The advantages of the sectional floating dock for

economical operation are many. With this type of dock the cost of pumping is directly proportional to the displacement or weight of the vessel to be lifted. In the case of docking a vessel which is much smaller than the capacity of the dock, only a sufficient number of sections have to be used to accommodate it, while with a steel floating or graving dock, the whole dock must be operated. The sectional floating dock is thus more economical for docking vessels of various sizes than the other types.

As the quantity of water to be pumped is generally less in the floating dry dock, the time required for the actual lifting is considerably less than that required for removing water from a basin dock. The floating dock needs only to be lowered sufficiently to place the ship over the keel blocks, while with the basin dock the amount of water above the blocks, regardless of the draft of the vessel, must always be handled. Floating docks can lift vessels whose length exceeds that of the dock. It is generally conceded that sectional docks are more easily handled than other types.

Other Advantages

Floating docks are better able to deal with vessels having a list or an abnormal draft. The dock is on a level with the surrounding shops, which is a saving in time and labor; it has the advantage of better sanitary conditions and atmospheric surroundings, there being an abundance of light and fresh air. The paint on ships' bottoms dries more quickly and the sewage from the ship can be better taken care of than in the basin dock. The floating dock has the ability to maintain a vessel in virtually the same shape as when water-borne.

In conclusion, therefore, the writer believes that, while each type of dry dock is particularly useful for a given set of conditions and requirements, the wooden sectional floating dry dock is the commercial choice where returns on the investment is the prime consideration.

Novel Method of Launching Adopted at Puget Sound Navy Yard

Ammunition Ships and Target Rafts Built in Basin Dock and Launched Simultaneously by Flooding the Dock

BY E. R. BOUVIER*

ADVANCES in shipbuilding have not ceased. In marked contrast with the usual methods of building and launching vessels, which have been followed since shipbuilding was begun, it has remained for the Puget Sound Navy Yard to introduce in the year 1919 an entirely new type of building berth and a new method of launching ships. On December 16 there were launched at this plant the U. S. S. *Pyro* and the U. S. S. *Nitro*, each a 10,000-ton ammunition carrier for the U. S. Navy, and two Navy target rafts, each 172 feet long. The whole launching operation for the two vessels and the two rafts required a gang of but 332 men and consumed but three hours' time until the craft were in the water and tied up at their respective piers. The entire cost of the operation amounted to $2,000 (£410).

Instead of the usual method, these vessels and rafts were built in a huge shallow basin or dock, the bottom of which is below sea level and especially constructed at this Navy Yard for shipbuilding purposes. This so-called building berth, or shipbuilding dock, is 950 feet long, 130 feet wide and 30½ feet deep measured from the top of coping, which is even with the grade of the main industrial portion of the yard. The bottom of the dock is 8½ feet below low tide and 28 feet below high tide.

The basin is filled through two 14-inch sea flooding valves in the caisson gate and through one 6-foot by 6-foot flume through the concrete wall at the end of the dock. At the time of the above launching it required just 61 minutes to fill the dock to the full tide of 21 feet, which gives a depth of water of 24½ feet above the bottom of dock.

The two ammunition ships are sister ships, each of 10,000 tons displacement, 460 feet long, 60 feet beam and 39¼ feet molded depth. The christening ceremony was performed on board, the bottle being broken over the bow of the vessel from a temporary christening platform erected on the main deck at the bow. The two vessels were christened simultaneously, at a given signal. The U. S. S. Pyro was christened by Mrs. G. A. Bisset, wife of Commander G. A. Bisset, (C. C.) U. S. N., the naval constructor in charge of the building of the vessels, and the U. S. S. *Nitro* was christened by Mrs. Henry Suzzalo, wife of the president of the University of Washington.

The launching operation was similar in all respects to the ordinary undocking of a vessel from a dry dock. As soon as the dock was filled the huge steel caisson, or gate, at the dock entrance was floated and moved out clear of the entrance. The vessels were then floated out of the dock and moored at their piers.

An interesting discussion arose as to the proper moment to christen a vessel launched in this manner. Some suggested that the ceremony should take place when the water touched the keel, and others suggested that the most appropriate time would be when the vessel was just water-borne. The latter suggestion was adopted. A naval officer, stationed at the head of the dock in clear view of the flooding operations, sounded a signal with an air whistle at the moment when both vessels were afloat, which was exactly at 12:46 P. M.

That the launching was entirely without the usual spectacular effect was plainly evidenced by the peculiar questioning looks on the faces of the several thousand visitors.

Had the shipbuilding dock not been needed for the building of two other large vessels awarded to the yard, it would have been entirely practicable to have completed the vessels in the dock and hauled them out with steam up and the trial boards aboard ready to proceed to sea for the official Navy trials.

Thus in the new style of building ways all problems of ground ways, launching ways, releasing mechanisms, retarding effects, launching calculations, proper grease to use, etc., are done away with. But one serious aspect presented itself in the whole operation, namely, that once the vessels were afloat, it was necessary to be prepared to see that either the vessels be removed from the dock or that they be reseated on their blocks before the tide had fallen to such an extent that the vessels' keels would not clear the sill of the dock entrance, or the top of the keel blocks, in case reseating of the vessels should have become necessary. The top of the keel blocks is 4 feet above the bottom of the dock, and, as the draft of the heaviest vessel at the time of launching was 14 feet, and as there was 19½ feet of water above the keel blocks, there was about 6 hours' leeway, in case of accident, before reseating would have become necessary. The whole launching operation was pronounced a decided success by all.

* Assistant superintendent, Navy Yard, Puget Sound, Washington.

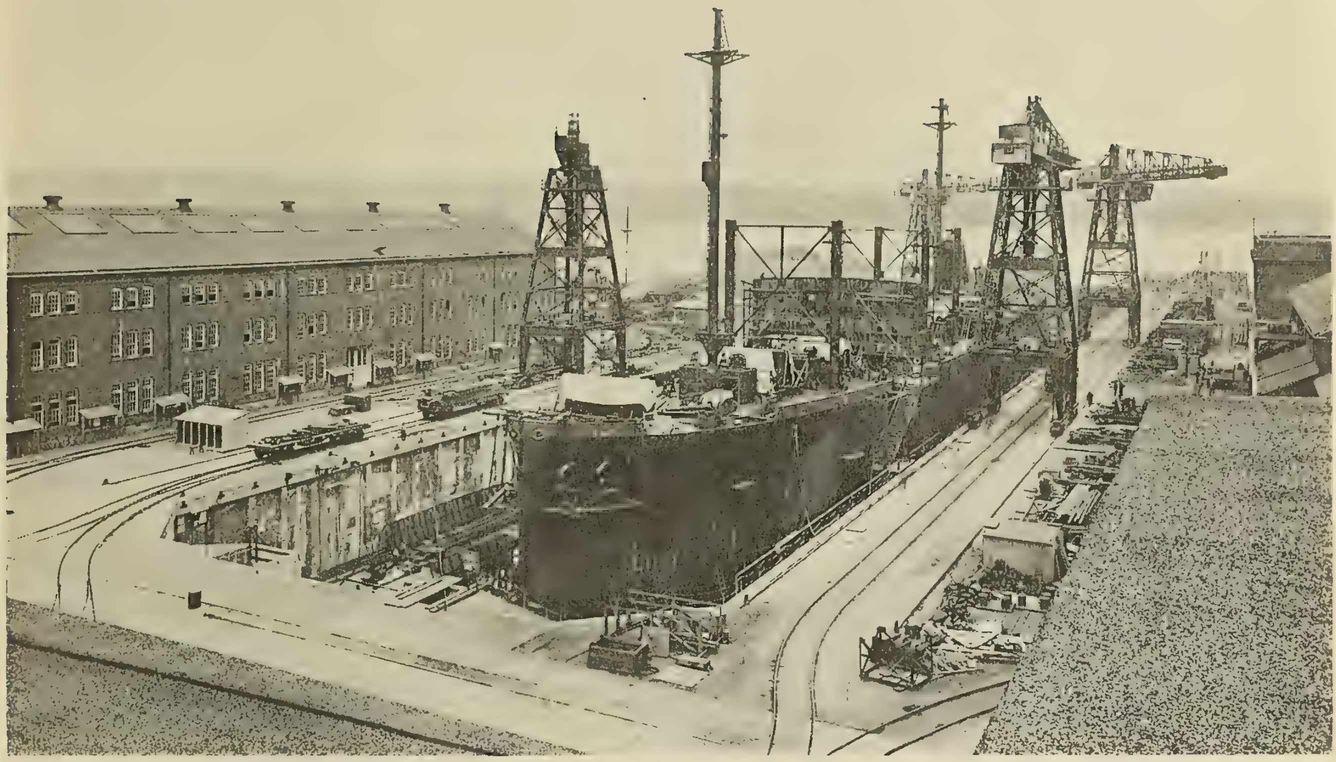


Fig. 1.—General View of Shipbuilding Dock, Showing Ammunition Ships Under Construction

Fig. 2.—Launching Ammunition Ships *Pyro* and *Nitro* at Puget Sound Navy Yard by Flooding Basin Dock in Which They Were Built

(Sketch by C. McKnight Smith, New York)

Fig. 1.—General View of Pinto Island Plant of Alabama Dry Dock and Shipbuilding Company, Mobile, Ala., Showing New 10,000-Ton Floating Dry Dock in Operation

Fig. 2.—Waterfront of Busy Alabama Dry Dock Plant

New Floating Dry Dock Built at Mobile

10,000-Ton Donnelly-Type Wooden Dock Added to Pinto Island Plant of Alabama Dry Dock and Shipbuilding Company

WHEN the Alabama Dry Dock and Shipbuilding Company, Mobile, Ala., was formed in January, 1917, the plants formerly owned by Ollinger and Bruce Dry Docks Company, the Gulf Dry Dock Company, the Alabama Iron Works and the Gulf City Boiler Works were united and a large addition was made to the establishment by building a complete unit on Pinto Island for vessel repairs. As the Pinto Island plant comprises the main department of dry docking and repairs, plans were made at the outset to provide ample facilities for this class of work.

William T. Donnelly, consulting engineer, New York, was retained as consulting engineer, and at the outbreak of the war had prepared preliminary drawings for a new dry dock. The subsequent rise in prices of labor and materials caused by war conditions made it necessary to refinance the undertaking, which was brought about by an agreement with the United States Shipping Board, and resulted in the building of a 10,000-ton floating dry dock with ten pontoons, the dock to be built in two sections.

The overall dimensions of the dock are as follows: Length on keel blocks, 480 feet; length on wings, 420 feet;

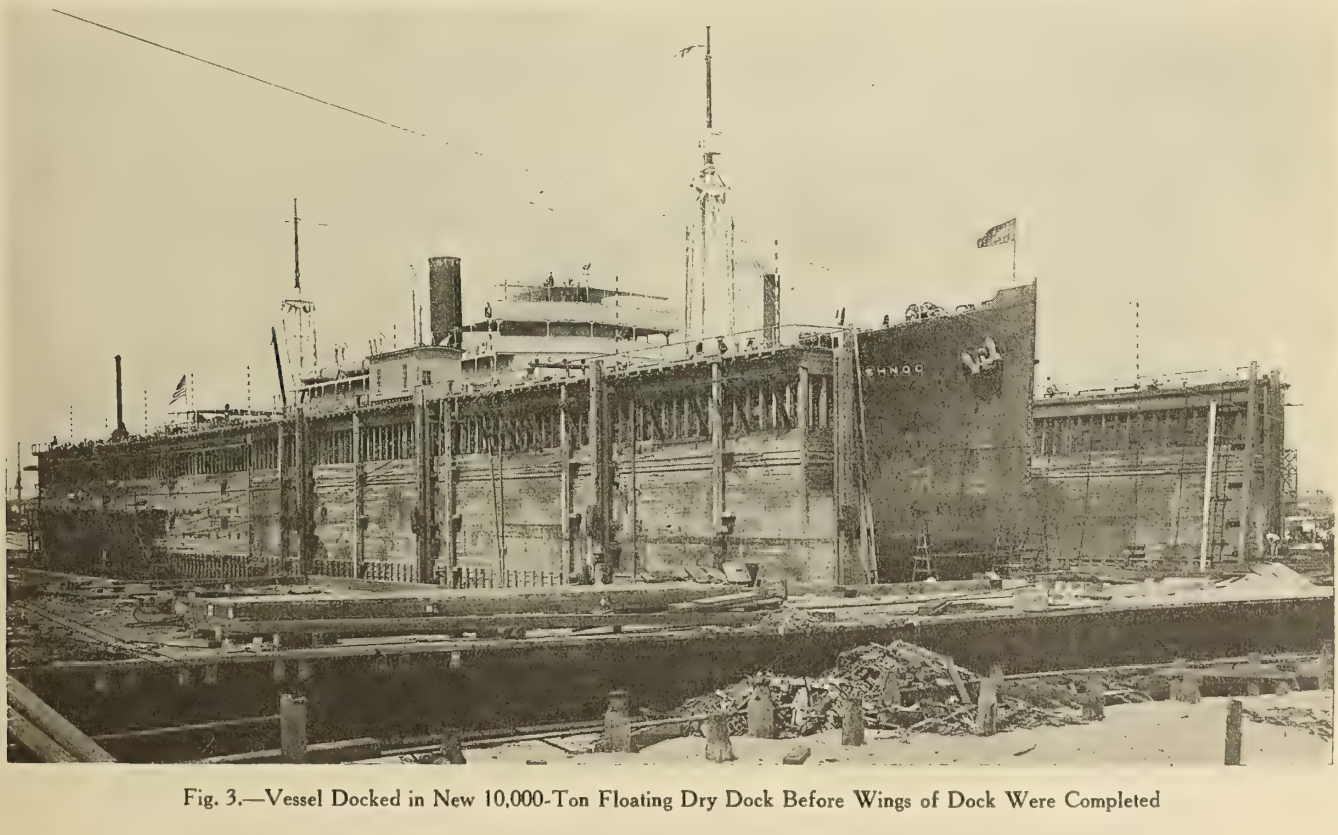


Fig. 3.—Vessel Docked in New 10,000-Ton Floating Dry Dock Before Wings of Dock Were Completed

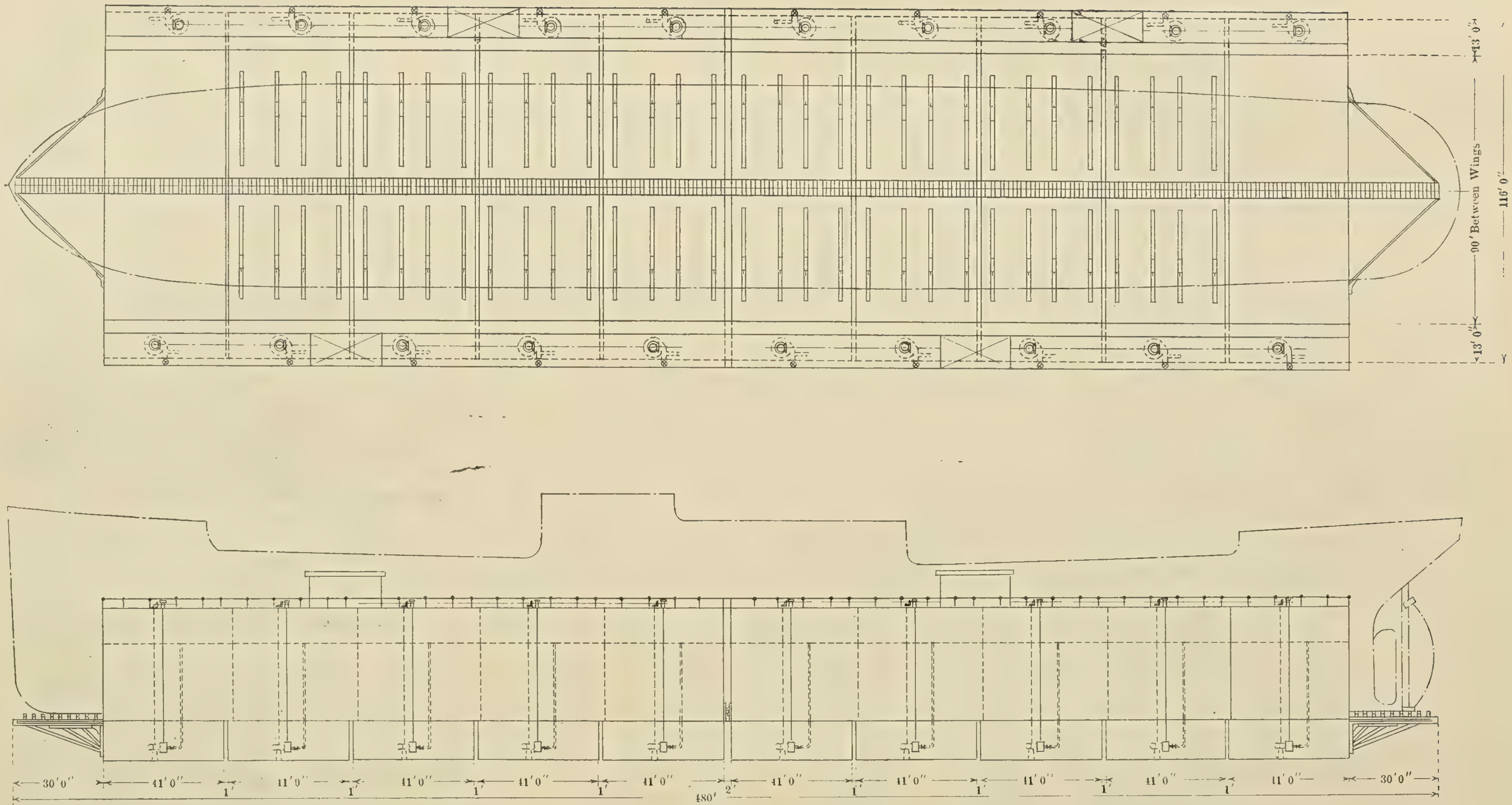


Fig. 4.—Plan and Elevation of 10,000-Ton Donnelly-Type Floating Dry Dock Built at Mobile, Showing Pumping Arrangements and Principal Dimensions

Fig. 5.—View Showing Unfinished Sections of New Dry Dock

overall width, 116 feet; width between the wings, 90 feet.

This dock was designed to take a draft of 22 feet over 3-foot 6-inch keel blocks. The pontoons were each 41 feet in width by 13 feet 3 inches deep. The wings are 13 feet wide at the bottom, 9 feet wide at the top, and 37 feet 3 inches high. Both the wings and pontoons are built of very carefully selected Southern yellow pine.

To bring about the sinking of the dock, tanks are provided in the upper part of the wings into which sufficient water is pumped to cause the dock to submerge to the desired depth. The pumping machinery is operated by electricity and consists of twenty 12-inch centrifugal pumps. Electricity is supplied for operating the motors from a local central power station.

The location of this dock in a slip required a very considerable amount of dredging and pier work. This dredging was so disposed as to raise a very considerable part of Pinto Island above the extreme Gulf level, and for the first time in the harbor of Mobile both the pier work and this area of the industrial plant was raised above the

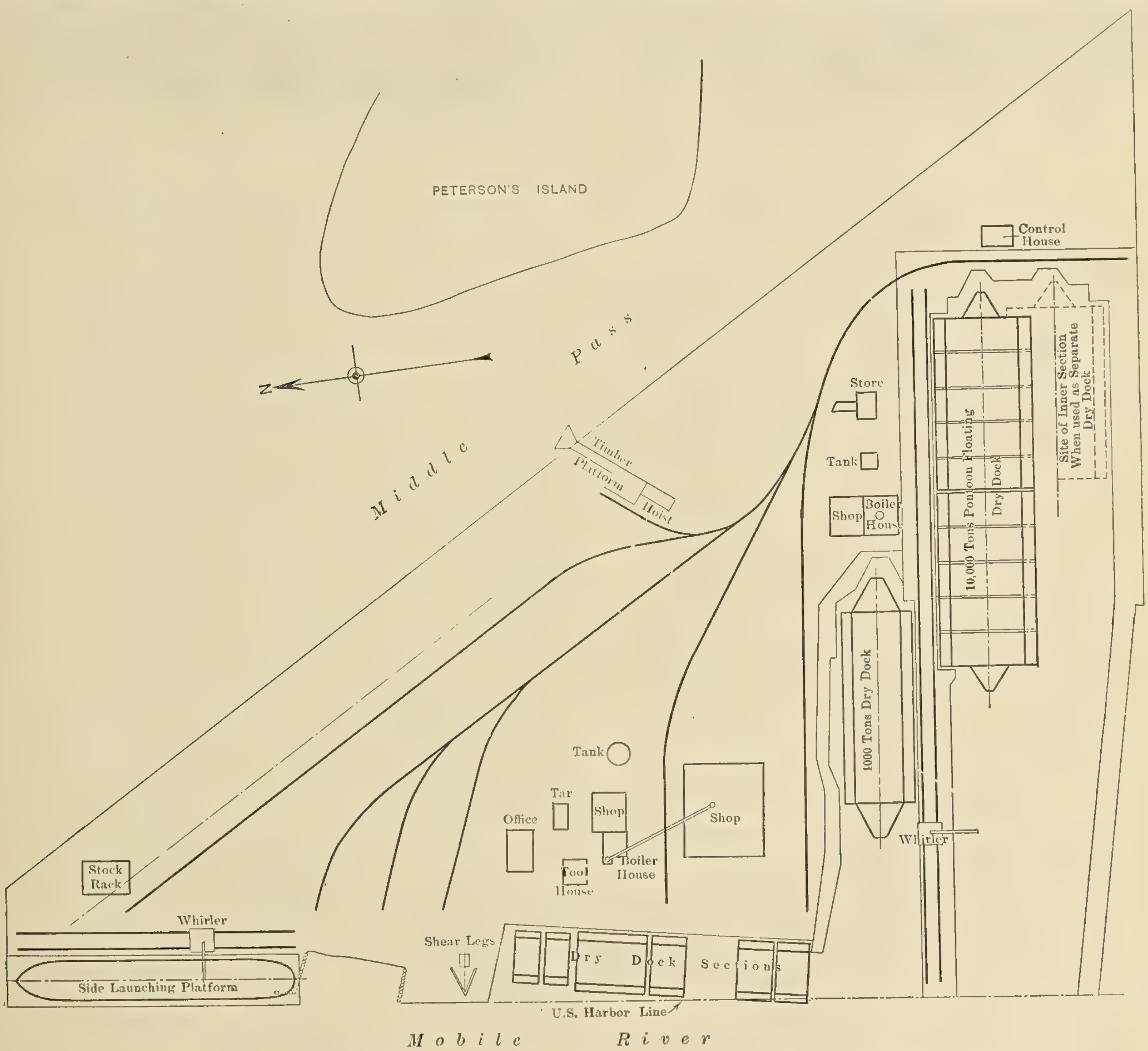


Fig. 6.—Map of Pinto Island Repair Plant of Alabama Dry Dock and Shipbuilding Company

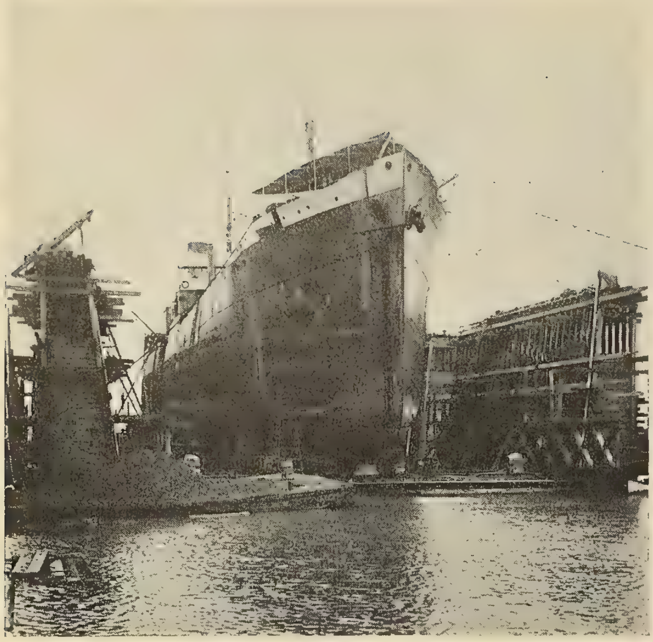


Fig. 7.—Vessel Docked in Partially Completed Dry Dock

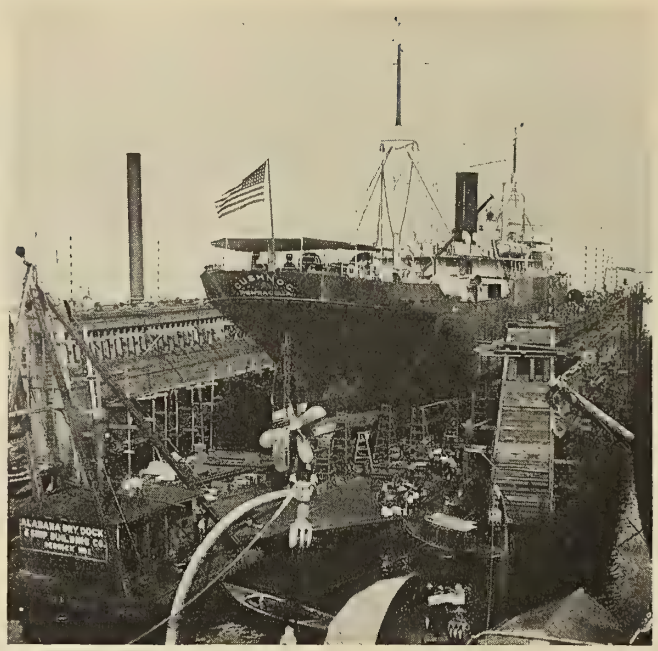


Fig. 8.—S. S. *Cushnoc* in New Dry Dock. Wings of Dock Unfinished

record level of the Gulf, due to westerly hurricanes, thus insuring the plant against interruption and loss due to storm conditions.

The first section of the dock was completed so as to dock the first vessel on May 23, 1919. This vessel, the steamship *San Antonio,* having a length of 395 feet overall and a beam of 50 feet 4 inches, was altogether too long to be docked upon this section, therefore the expedient was adopted of using two pontoons completed for the second section and erecting temporary wing structure upon them in such a manner that temporary pump connections could

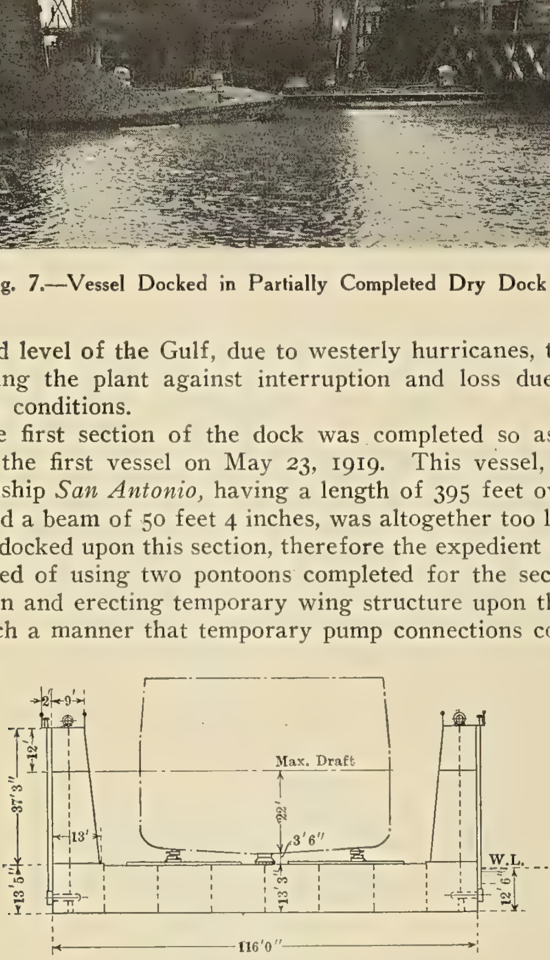


Fig. 9.—Section of 10,000-Ton Donnelly Dry Dock

be made and these two pontoons used to aid the first section in docking the vessel. This was successfully carried out and the *San Antonio* remained on the dock about seven weeks, during which time a very considerable additional amount of work was performed upon the wings of the second section. This we believe to be the first time on record when part of an uncompleted floating dry dock was used in docking a vessel without interrupting its construction.

Docking has continued with only slight interruptions of the work on the second section, and up to and including December 25, 1919, this dry dock had docked 23 vessels having a total displacement of over 100,000 gross tons. The date of completion of the dock had been agreed upon by the builders and the Shipping Board as December 31, 1919.

The pumps for this dock were furnished by the Morris Machine Works, Baldwinsville, N. Y., and the electric motors by the General Electric Company, Schenectady, N. Y. The pumps and machinery were installed by Frank Tracy, of New York. The lumber, amounting to 3,500,000 board feet, was furnished by the Mobile-Gulfport Lumber Company, of Mobile, Ala.

By reference to the general view of the plant (Fig. 1) and also the plan shown in Fig. 6, it will be seen that the Alabama Dry Dock and Shipbuilding Company has a very complete plant on Pinto Island, comprising, besides the 10,000-ton dock just described, a 4,000-ton box dock and six small sections, which can be manipulated so as to form several smaller docks. There is also a side-launching platform on the upper end of the island and a woodworking shop, office and other buildings. The machine shop of this company is now located on the Mobile side of the river, but it is planned eventually to have the whole operation concentrated upon Pinto Island.

Shipping on the Gulf is developing very rapidly and this company has its entire plant fully engaged.

Manning of American Ships

The total number of masters, officers and men required at the present time to man the registered, enrolled and licensed vessels of the United States, including 1,450 documented yachts, and aggregating in round numbers 15,325,000 gross tons, is, in round numbers, 266,000. The List of Merchant Vessels of the United States for June 30, 1919, to be issued in March by the Bureau of Navigation, Department of Commerce, shows the number of the crew (excluding master) of the 29,600 vessels and yachts included in the list. Adding the master for each vessel, the totals of the list are as follows:

Vessels	Number	Masters and Crew
Steam vessels	7,817	156,114
Motor vessels	11,525	42,941
Sail vessels	4,474	24,672
Unrigged vessels	5,853	11,425
Total	29,669	235,152

The new vessels documented since the list went to press require masters, officers and men aggregating 31,000 in round numbers, making a present total of 266,000.

Our salt-water tonnage is now nearly three-fourths of the total tonnage; but, as it includes the larger ships with relatively small crews in proportion to tonnage, the total number required to man our salt-water ships at this writing may be estimated at about 175,000.

Senate Committee Conducts an Open Forum on Questions of Merchant Marine Policy

BY WALDON FAWCETT

FREE opportunity for expression in a wide field of discussion under the stimulus of a not unfriendly cross-examination has resulted, thus early in 1920, in the inauguration of the most ambitious open debate yet attempted on the questions at issue in the formulation of a permanent national policy with respect to the American merchant marine. The committee on commerce of the United States Senate (facing the responsibility of recommending to the upper house of Congress legislation to meet the post-war needs of American shipping and shipbuilding interests) has been conducting an open forum with an intent to bring forth first-hand evidence and expert opinion on every phase of the complex subject. Needless to say, participation in the discussion has not been limited to legislators. Rather have the senators formed an audience to which has been related the experiences and the deductions of practical men qualified to speak with authority.

Senate Committee Open-Minded

It was significant that in opening, the latter part of January, the series of hearings now in progress, Senator Wesley L. Jones, chairman of the commerce committee, stated that he had "no set views" as to how to work out the problems that are presented. Commenting on the magnitude of the task that is faced, the chairman said: "We have met to prepare legislation for the upbuilding and maintenance of an adequate American merchant marine in foreign commerce. This I consider one of the most important as well as one of the most difficult problems confronting Congress. It is important because such a marine is essential to our national defense and for our proper commercial growth and development. It is difficult because during the last fifty years but few of our people have engaged in the operation of ships and we have no established banking or commercial facilities necessary in a great shipping business.

Shipping Lines to Be Established

"We must create a system under which shipping lines will be established, commercial agencies and financial facilities created and maintained, suitable ships built and kept in operation, and our people led to think and act in terms of ships and shipping activities. This will have to be done in the face of the most determined opposition and the fiercest competition of those long established in the business and equipped by experience and the most efficient commercial and financial agencies. I think we can assume that all members of the commerce committee are agreed as to the importance and need of a merchant marine and we can well direct our attention almost entirely to the consideration of concrete means to accomplish the purpose and object desired by all." Incidentally, it was made clear that the present open forum on the subject of the merchant marine is not in any sense an investigation of the United States Shipping Board, as have been some of the hearings conducted in Washington this past year or two, but is purely a constructive parley in quest of the best legislative policy for the upbuilding of the merchant marine.

A number of men well known in shipping and shipbuilding circles have, during the past few weeks, filed statements with the commerce committee outlining their views on phases of the general mercantile marine subject that they deem of especial importance. John H. Rosseter, former director of operations of the Shipping Board, and now vice-president and general manager of the Pacific Mail Steamship Company, seeks to impress upon the framers of legislation the need of means to reduce capital cost, which he deems the most serious item in course of operation. His deduction is as follows: "I figure roughly that the 'capital cost charges' alone on a passenger vessel valued at, say, $4,000,000 (£820,000) would amount to $1,800 (£370) per day. Therefore we must find some way to permit by law to write the cost down as quickly as possible. I would venture to suggest a write-off of 10 percent for the first five years, or, better still, a sliding scale beginning, say, at 12 percent for the first two years, when good earnings can be expected, at 10 percent for the third and fourth years, and at 8 percent thereafter, until two-thirds of the cost has been recovered; otherwise the good results which are possible under prevailing conditions would be eaten up by excess profits tax, and at the end of five years our shipowners will have high book values on their hands and find it impossible to compete with other nationals with low capital cost on their ships."

Policy of the Japanese Lines

Yonejiro Ito, managing director of the Nippon Yusen Kaisha, is quoted by Mr. Rosseter as having stated in Japan that shipping men agree that in the future there will be a decline in the value of ships. Accordingly, it has been suggested to the Japanese executive that perhaps the Nippon Yusen Kaisha had better wait until such decline has materialized before undertaking the construction of 500,000 tons of ships to improve the new shipping lines which were opened by the company during the war, particularly inasmuch as not more than half of the new ships will be built in Japan, it being necessary for the Japanese corporation to look to outside shipyards for a considerable proportion of its new ships of 8,000 tons each with a speed of 20 knots. To this argument for delay in placing contracts for new ships, the significant reply of Managing Director Ito was that no ships in service anywhere are valued at a lower figure than are the vessels of the Nippon Yusen Kaisha, thanks to the policy of the company in quickly writing off cost by means of reserve funds. Finally he made the claim that even if the 500,000 tons of new ships for the Japanese lines be built at the ruling cost the company will be able to put their valuation at a low figure.

Pacific coast shipping and shipbuilding interests have been energetic in presenting at Washington pleas for the class of legislative aid that is deemed essential for the upbuilding of the industry and its continuance on the west coast. Benjamin S. Grosscup, representing the Pacific Steamship Company, while denying any intent to ask for a direct government subsidy, urged the extension of Federal aid to "keep our ships in use." His theory is that if foreign shipowners are found to have, as compared with Americans, a substantial advantage in the cost of operation, in the capitalization of a fleet or in insurance it will

be necessary to do one of two things to sustain the American merchant marine: either there must be eliminated the obstructions to economical operation that now exist or else American shipping interests must be placed on a par with those of foreign nations by some form of compensation to meet the difference in cost of operation. His solution for the problem of the inequalities faced by American shipowners is that instead of the surplus tonnage that the Government acquired during the war being allowed to go under foreign flags, all such vessels should be sold under the restriction that they be kept under the American flag and sold at a price that will enable the purchasers to operate them.

Merchant Marine Corporation Proposed

A. F. Haines, vice-president and general manager of the Pacific Steamship Company, presented at Washington an endorsement of the plan for the organization of a Federal Merchant Marine Corporation which would take over all the vessel property and present holdings of the Emergency Fleet Corporation and which, with an assured life of at least 25 years, would be authorized to own, buy, sell, charter and build vessels, shipyards, terminals, etc. This corporation would proceed to sell the fleet now in the hands of the Government at reasonable prices for specified trades on terms of 5 percent cash and 5 percent per annum—it being the contention that the terms given would enable American shipping companies to absorb the fleet and operate the vessels. The Government would, under this plan, receive, in addition to the 5 percent per annum, 20 percent of the net earnings of the vessels, this latter being sufficient supposedly to cover the overhead of the Merchant Marine Corporation.

A considerable proportion of the expressions of opinion that have reached the commerce committee in oral or documentary form have come from attorneys and other representatives of commercial organizations, whose arguments are not, as a rule, grounded on extensive first-hand experience. Fortunately, however, the senatorial body has also had the benefit of advice from practical men. One of the latter, who spent an afternoon with the committee, was Frank C. Munson, of the Munson Steamship Company, of New York. Mr. Munson gave his personal appraisal of the current situation as follows:

Mr. Munson's Views

"It is my belief that the most vital necessity today for the benefit of the merchant marine—for the benefit of the shipbuilding industry in this country—is that a policy should be decided on and published as to what is to be the future proceeding in regard to the Shipping Board—whether it shall continue as owning the major portion of the tonnage of this country or whether it is to sell its tonnage, and if so, at what price. My belief is that the Shipping Board should sell all its tonnage within a period of six months, on a basis of $100 (20/16/8) per ton value, plus $10 (2/1/8) to $25 (5/4/2) per ton on the new and larger type boats which have been solely and entirely built since the armistice was signed, and with a depreciation of 10 percent on the $100 (20/16/8) value for vessels built or commenced to be built during the period of the war. $100 (20/16/8) to $125 (26/0/10) per ton is the basis on which England is selling its ships to her private operators, and they have an average operating cost of about 40 percent lower than ours."

In order to get before the committee concrete evidence in parallel columns, so to speak, of the relative costs of operation of American and British vessels, Mr. Munson submitted figures for the *Walter D. Munson*, an oil burner under the American flag, and the *Munarder*, a coal burner under the British flag, these vessels, of 5,800 and 5,700 tons respectively, being engaged at present in the service between New York and Cuba. The cost of operating the American vessel was given as $4,262 (£875) per month, whereas the cost for the British vessel is 723 pounds sterling, which at the prevailing rate of exchange makes the cost not much more than 50 percent of the outlay for the American vessel.

Taking as his text the fact that "the biggest single item of operating cost is the capital cost of the vessel," Mr. Munson declared that in the case of a 10,000-ton steamer, an American vessel, is, on the basis of extra capital charge, at a disadvantage of $548 (£112) per day as compared with a British vessel of equivalent capacity, whereas, as Mr. Munson expressed it, "in normal times a difference of $50 (10/8/4) a day would be enough to give all the advantage in the world to the British boats and let them take away our trade."

Munson Line in the Market for Ships

The head of the Munson company stated, in answer to the questions of senators, that his corporation is ready to buy ships, adding: "We have a reserve for that purpose, as any properly-operated American company has." His calculation was that the Munson interests would purchase not less than 25 to 30 steamers, if offered on the present basis of 25 percent payment which the Shipping Board is now allowing. The types of vessels required by this interest would be freight vessels ranging from 8,000 to 10,000 tons and passenger and freight vessels of 15,000 to 20,000 tons for express service. About half a dozen of the combined freight and passenger steamers are contemplated in the above requisition, it being the calculation to place two of these vessels in the service between New York and Cuba and four in the South American service, calling at ports in Brazil, Uruguay and Argentina.

Discussing, by suggestion of members of the committee, the situation with respect to the smaller vessels constructed for the war emergency, particularly the steamers of 4,500 tons and under, Mr. Munson gave it as his opinion that if these were offered today on the $100 (20/16/8) per ton basis (the Government absorbing its loss as a part of the war cost), "a good many of them could be sold to American owners." He predicted, however, that if disposition is delayed it will be difficult to sell any considerable proportion of them. In explanation of his skepticism, he commented: "The vessels that were started during the war and built during the war under the hurry-up process—quick riveting and hurry-up work all the way through—are very poor vessels. They have leaky rivets, trouble with their engines, and trouble with their accessories, and the result is that their repair bill is so large that you cannot operate them in competition and make any money." Incidentally, the committee's informant characterized the fabricated ships as "inferior" vessels because of the bluff bows and square stern, as well as by reason of what he designated as the "quickriveting."

The shipowner made it clear, however, that his criticism was leveled only at the vessels constructed during the war. "My opinion," he remarked, "is that the ships being constructed today and since the armistice was signed are good vessels." In testimonial to the high estimate placed by shipowners on vessels built in American yards since the armistice, Mr. Munson gave it as his belief that nearly all—certainly 75 percent of the steel vessels started since the armistice—would be absorbed within a year by private

(*Concluded on page 225.*)

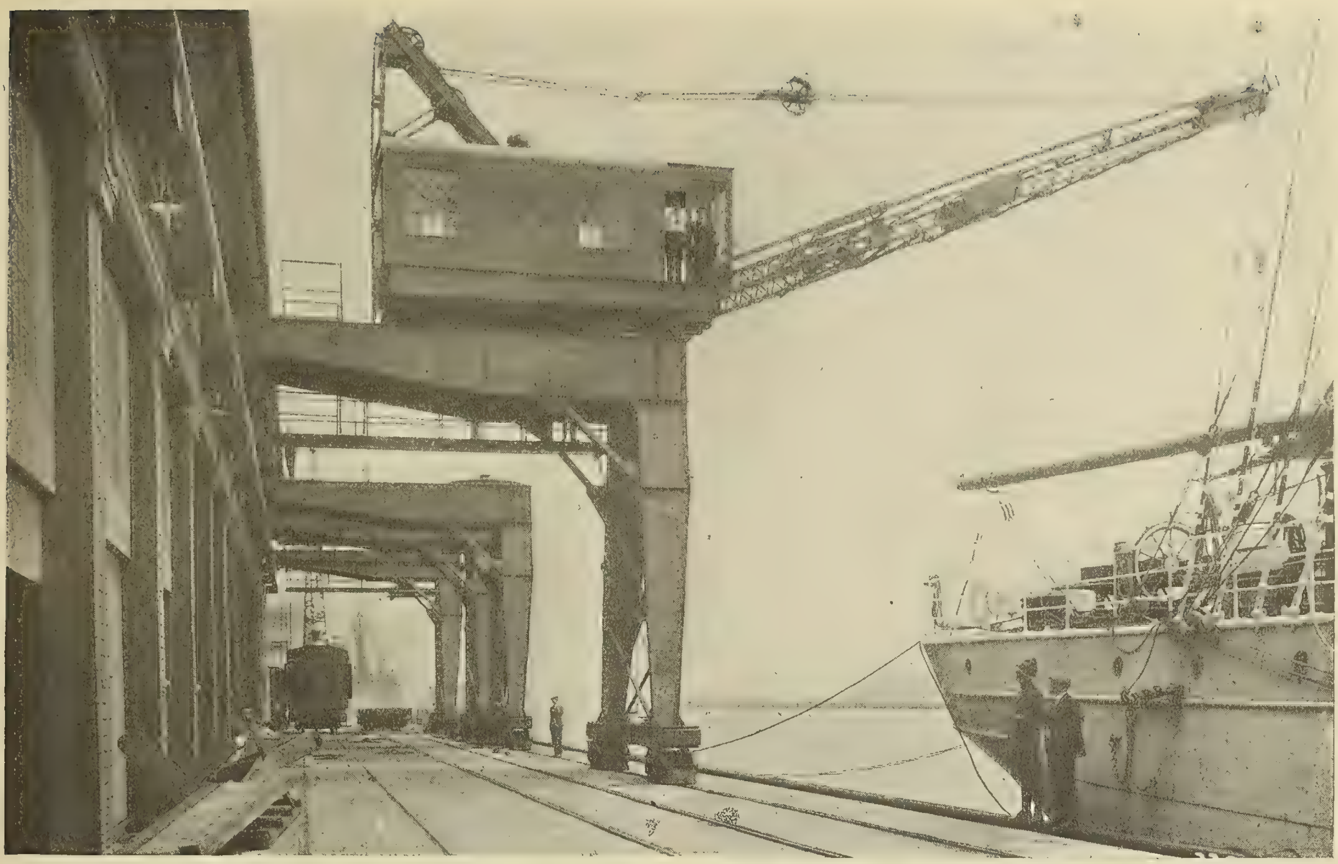


Fig. 1.—Semi-Portal Wharf Cranes Built for the United States Army Supply Base, Boston, Mass.

Bridge Cranes at the Boston Army Base

Apparatus Designed by Wellman-Seaver-Morgan to Handle 5,000- to 8,000-Pound Loads—General Electric Motor Equipment—Special Safety Devices

FOUR semi-portal bridge type hoist cranes are now being installed at the United States Army Supply Base, Boston, Mass. The first of these cranes, shown in operation in the accompany illustration, carries a lifting boom operated from a carriage, which in turn is mounted on a semi-portal bridge and arranged to rotate about a fixed axis.

The crane has four distinct motions: bridge travel along the wharf; trolley slewing; boom hoisting or luffing; and load hoisting. All of these motions are under the control of the operator located in the cab on the rotating carriage. Another drum can be added and a two-rope grab bucket operated.

Capacity of the Crane

The crane is rated to handle 8,000 pounds at a distance of 29 feet from the face of the capsill at the rate of 200 feet per minute, and 5,000 pounds at a distance of 52 feet at 250 feet per minute. It will, however, take care of occasional loads of 8,000 pounds at 52 feet from the center of rotation without undue stress in any part of the crane. These cranes, designed and installed by Wellman-Seaver-Morgan Company, East 70th street and Central avenue, Cleveland, O., have a horizontal span of 26 feet 5 inches; the maximum reach of the boom from face to capsill is 44 feet, the minimum radius of the boom, 29 feet.

The angle through which the boom may be slewed equals 360 degrees. The boom may be hoisted or luffed at the rate of 125 feet per minute. Two rotations of the trolley per minute are possible with 5,000 pounds load at a maximum radius. The bridge travel along the wharf is at the rate of 200 feet per minute. The motion of hoisting or luffing can be operated simultaneously with rotating and traveling motions.

Special Construction Features

The semi-portal bridge supporting the operating mechanism was designed in accordance with the "General Specifications for Street Railway Bridges" issued by the American Railway Engineering Association in 1910, 100 percent being added to all live loads to allow for impact. Ample allowance has been made for the swaying of the load.

Each leg on the wharf side is carried on two wheels, driven through the necessary spur and bevel gearing by the traveling motor. Each pair of wheels is equalized for the proper distribution of load. On the shed rail, the frame is supported by two wheels, one at each corner. The flanges of the wheels running on the shed rails are placed to give about a seven-inch tread. Wheels running on the wharf rail have the flanges spaced to allow proper clearance for the head of the rail upon which they run.

The base frame is made up of rolled steel shapes and well braced plates. The revolving superstructure is carried on six steel rollers, four in front where the heaviest load occurs, and two on the back. A babbitted casting free to rotate about the center pivot pin is attached to the base

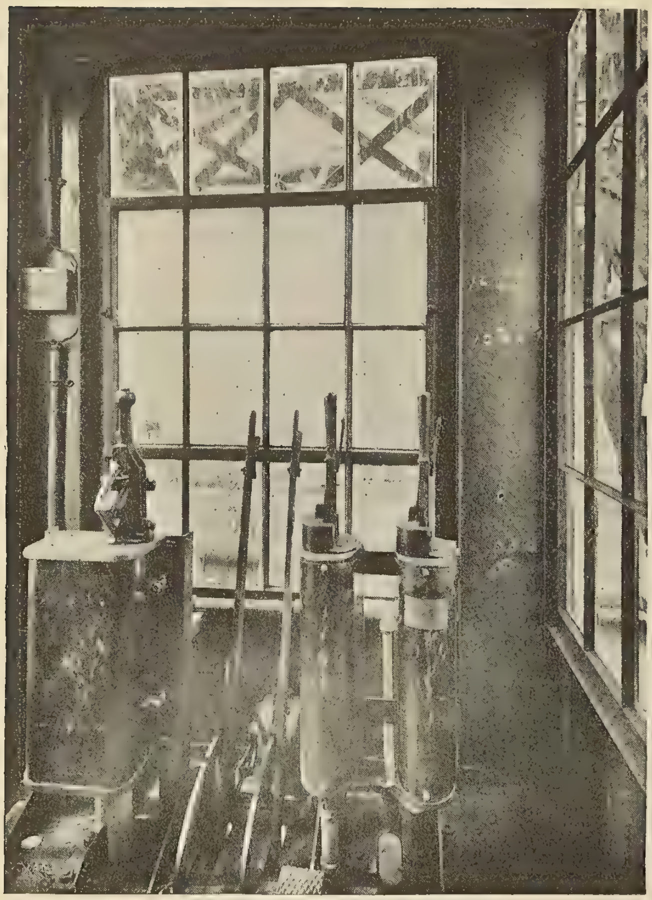


Fig. 2.—Interior of Operator's Cab

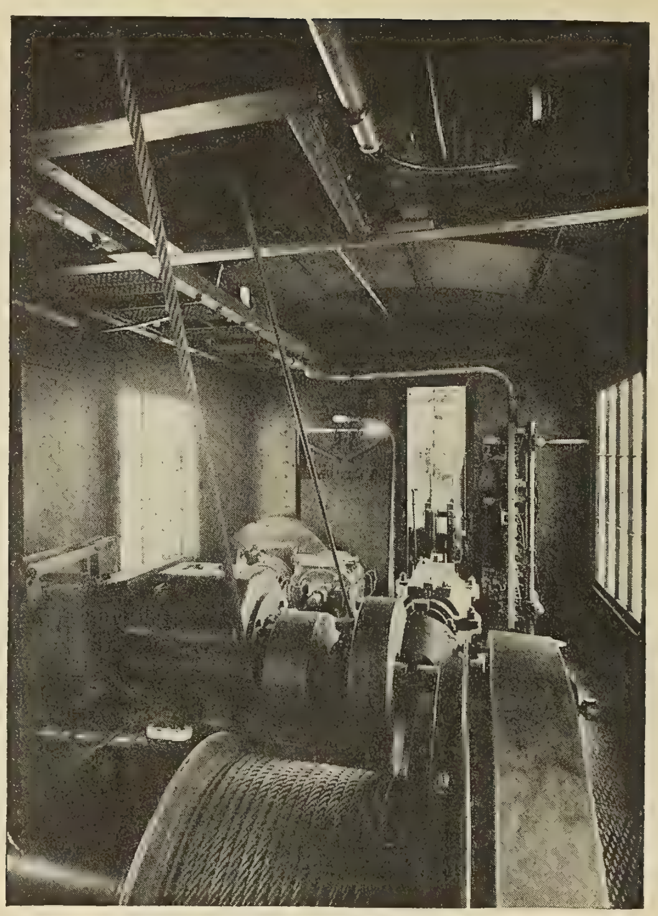


Fig. 3.—Interior of Machinery House

frame to hold the crane concentric with the center pivot pin and to transmit longitudinal and overturning loads from the revolving superstructure to the semi-portal.

The crane is designed so that under normal operating conditions, with a 5,000 pound hook load at the maximum radius, no appreciable load will be thrown on the center pivot load pin. It is, however, designed to transmit any possible vertical or horizontal load from the revolving jib crane to the semi-portal bridge without cramping or binding in any part.

The jib and main frame is made of well stiffened steel plates and shapes. The cab, composed of a steel framework covered with sheet steel, contains the main part of the hoisting, luffing and rotating mechanisms. The operator has an unobstructed view of the load at all times.

Operating Mechanisms

The hoisting and lowering mechanism includes a winding drum, driven through a jaw clutch and a train of spur gearing by a motor equipped with a solenoid break and necessary control apparatus and miscellaneous parts. The luffing of the boom is accomplished by a worm-driven drum operated by the hoisting motor through a jaw clutch and gearing so arranged that the boom can be raised or lowered at the convenience of the operator. The pitch of the worm is such that no mechanical brakes are required to prevent the load from lowering; but, as an additional safety, a pawl is provided to lock the luffing drum in any desired position.

The slewing is accomplished by means of a motor operated through a train of spur and bevel gearing and a pinion meshing with the master gear attached to the semi-portal bridge. A powerful foot brake is provided on this mechanism having a latch, by means of which the brake can be locked for any desired fixed position of the revolving superstructure.

A motor for traveling the bridge is mounted on one of the girders of the semi-portal bridge. One truck on the wharf rail is driven and one wheel on the shed rail. A solenoid brake is mounted on the armature shaft extension. Electrical connections between the conductors on the semi-portable bridge and on the revolving superstructure are made through collector rings mounted on the center pivot pin or an extension. In addition to the solenoid brake, hand operated rail clamps, as illustrated, clamp the wharf rail to hold the bridge in any fixed position.

Electrical Equipment

The electrical equipment is designed for a direct current of 230 volts. The motors, controllers and magnetic brakes are standard equipment of the General Electric Company.

In connection with the clutch shifting lever which en-

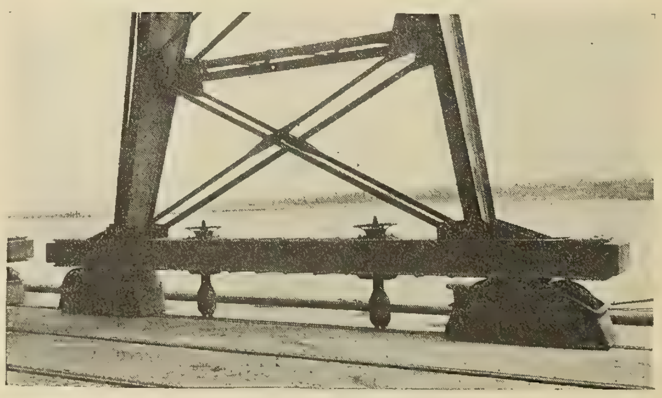


Fig. 4.—Trucks and Hand-Operated Rail Clamps

gages the hoist and luffing gearings with the driving motor, an interlocking switch, mechanically operated, prevents the starting of the hoist motor without load.

The slewing motor is controlled by a magnetic switch reversing plugging controller, consisting of a control panel, heavy duty, cast grid resister and vertical handle master controller. The plugging feature allows the motor to be reversed from full speed in one direction to full speed in the opposite direction without exerting over approximately 180 percent full load torque.

The bridge motor control, the company claims, provides for slow bridge speeds and also permits accurate control in case a favorable wind may help the motor in traveling, a condition which would ordinarily give an excessive speed.

Safety Devices

Ample provision is made for the protection of workmen. Guards extending down close to the rails and forming part of the truck brackets are placed in front of the track wheels. All gears are enclosed. Ladders and platforms provide access to mechanical parts of the crane, which are subject to inspection and repair. Hand railings are provided around all platforms. Sheaves are provided with tight fitting guards where necessary. A limit switch is provided to prevent over-travel in the hoisting direction on the main hoist motion. A pressed steel foot gong is provided in the operator's cab for signaling purposes, and a mechanical gong rings continuously when the bridge is in motion.

Launching Vessel in Narrow Waterway at Terry Shipyard, Savannah, Ga.

At the launching of the 7,500-ton oil tanker *Darden* at the yard of the Terry Shipbuilding Corporation, Port Wentworth, Savannah, Ga., on November 8, 1919, when Mrs. George Baxter, wife of the general superintendent of the yard, christened the vessel, some novel features were used. In the first place, special means of snubbing the ship became necessary, as the river at this point was only slightly wider than the length of the ship. Another novel feature was the use of steel tie plates for holding the sliding ways, which were cut by oxy-acetylene torches for releasing the vessel.

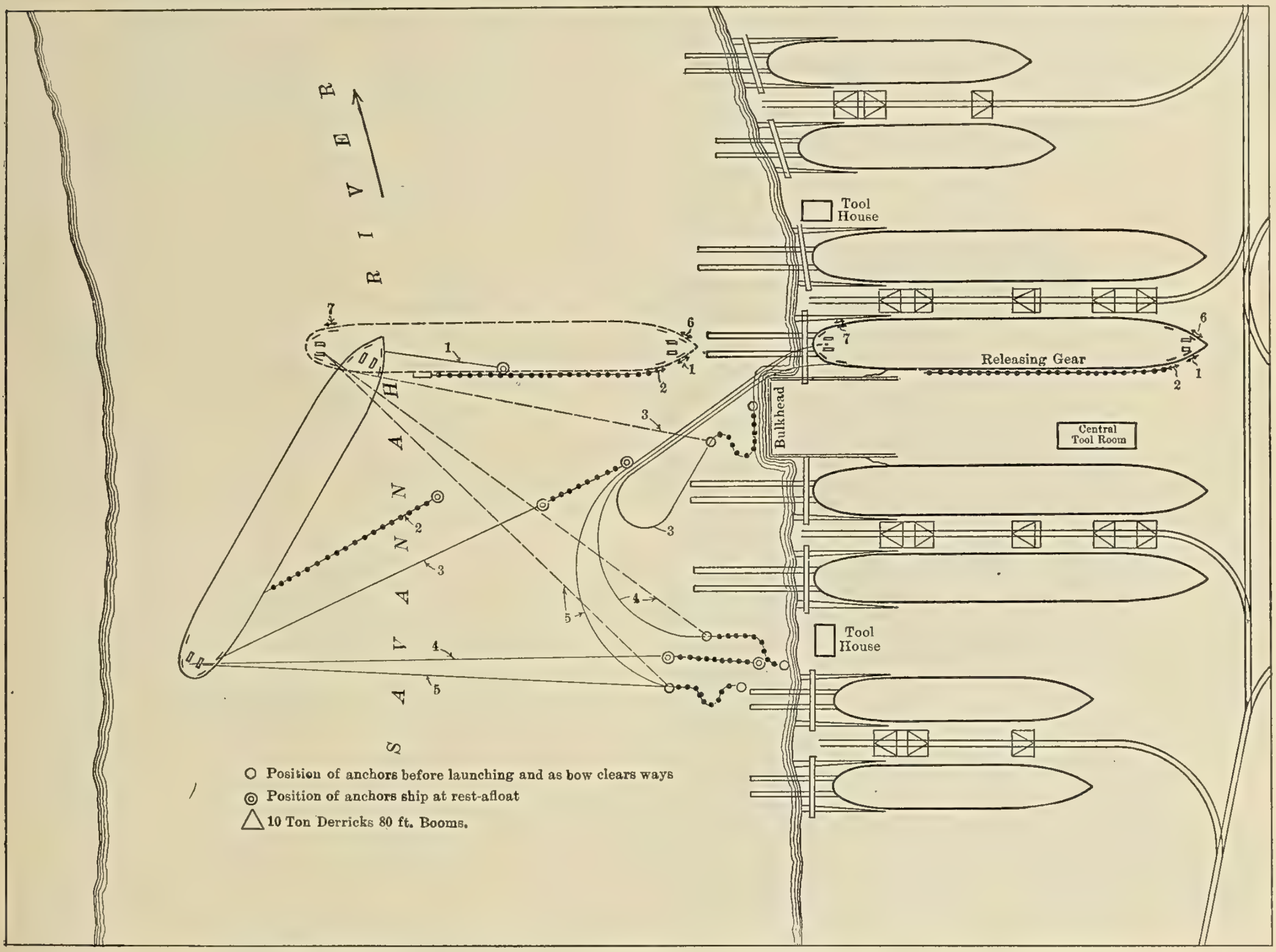


Fig. 1.—Snubbing Diagram

Snubbing the Ship

By referring to the snubbing diagram (Fig. 1), it will be noted that the river is quite narrow at this point, being only 600 feet from the end of the ways to the opposite bank. As the ship was 405 feet long overall, the space in which to swing the ship was quite limited. But this was accomplished very successfully in the following manner, using bower anchors:

No. 1.—An anchor of 4,025 pounds was attached to 150 feet of 7-inch Manilla hawser led through the forward starboard chock to a towing bitt on the forecastle deck.

No. 2.—An anchor of 7,400 pounds was attached to 270 feet of stud link chain, which was lashed to the side of the ship with the end of the chain shackled to releasing

gear. This gear was bolted to the side of the ship at the second deck between frames supporting watertight bulkheads and arranged to release the chain from the upper deck. This anchor was held in place by rope passing through the after starboard chock to a towing bitt on the forecastle deck. The ropes holding both No. 1 and No. 2 anchors were passed over a chopping block so that they could be cut, as will be explained later.

No. 3.—A steel cable 1¼ inches by 400 feet was led from the forward chock on the starboard side of the poop deck to the first anchor, which weighed 4,025 pounds. A second anchor, weighing 4,725 pounds, was attached to this cable with 90 feet of chain, laid so that the first anchor would drag 75 feet before taking up on the second anchor.

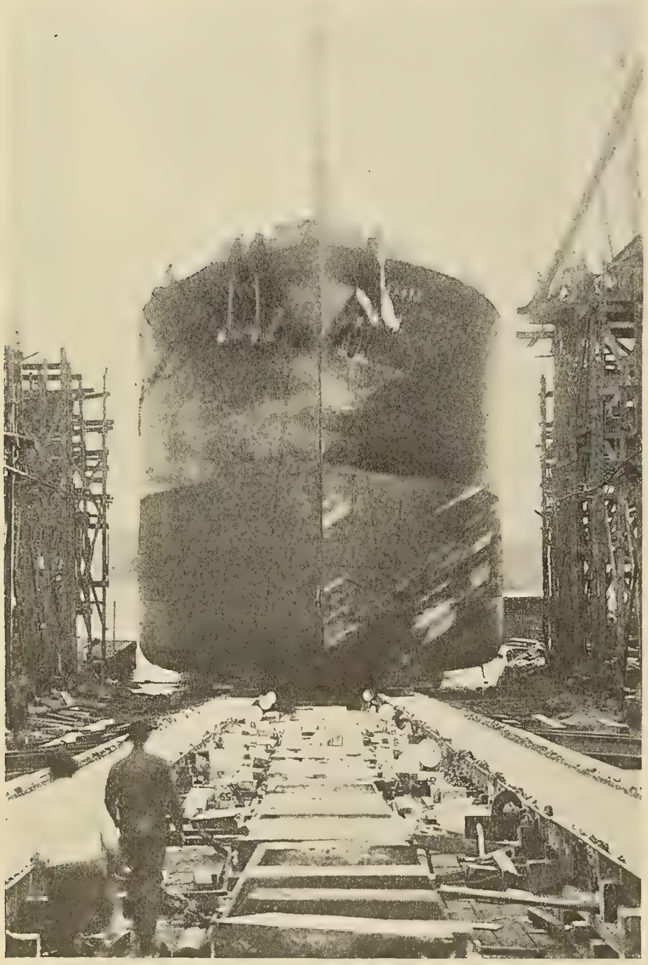


Fig. 2.—The *Darden* Going Down the Ways

No. 4.—A steel cable 1¼ inches by 500 feet long was led from the stern frame, through which it passed to the after chock and towing bitt on the port side of the poop deck to the first anchor (weighing 4,025 pounds). A second anchor, weighing 7,400 pounds, was attached to this cable with 90 feet of chain laid so that the first anchor would drag 20 feet before taking up on the second anchor.

No. 5.—A steel cable 1¼ inches by 500 feet long led from the stern frame, through which it passed to the forward chock and towing bitt on the port side of the poop deck to the first anchor (weighing 7,400 pounds). A second anchor, weighing 4,725 pounds, was attached to this cable with 90 feet of chain laid so that the first anchor would drag 20 feet before taking up the second anchor.

Anchors No. 6 and 7, lashed on the port side ready to cut loose, were emergency anchors, but were not used.

At the instant the ship left the ways, as shown in dotted outline (Fig. 1), anchors No. 1 and 2 were cut loose and cables 3, 4 and 5 were pulled up tight on the first anchors. When the ship swung around and came to a stop, as shown in solid outline (Fig. 1), her bow was about in line with the ways and had moved less than her length. All of the anchors had dragged to points shown by a double circle, except those attached to cable No. 5. The first anchor on this cable, forming the pivotal point on which the ship swung, moved less than three feet. The second anchor was not disturbed.

Floats were attached to all anchors and cables in order to locate them readily after being cut loose from the ship.

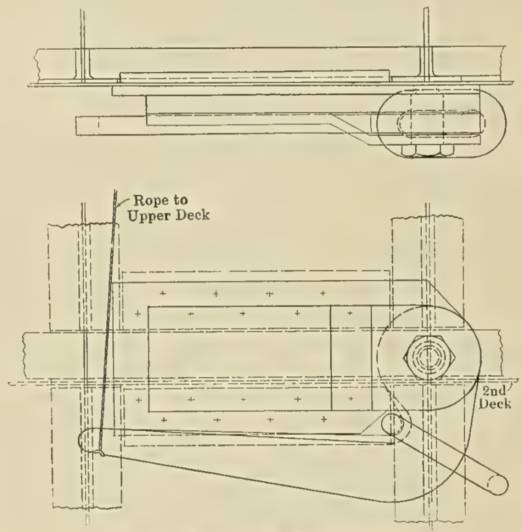


Fig. 3.—Details of Releasing Gear

Releasing Gear

The releasing gear was of the pelican hook type operated from the upper deck. It was to be used to release No. 2 anchor in case the ship was brought up too quickly; but, as a matter of fact, it was not used until the ship was at a standstill, when it was released with all other anchors to enable tugs to take the ship to its fitting dock, where it was tied up and crew dismissed at 10:22 A. M.

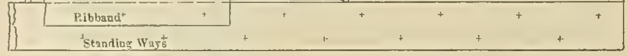


Fig. 4.—Tie Plate, Starboard Launching Way

The tie plates were 20.4-pound boiler plates rigidly bolted, one end to the standing ways and the other end to the sliding ways, with 6 inches between the ends of the ways. Burning was by means of acetylene torches, the progress of burning being called off in the usual manner.

Launching Programme

The launching programme was as follows:

12:01 A. M.	Start cleaning, drying and greasing outboard ways, following the tide out.
7:00	Launching crew report for work.
7:15	Start pulling grease plates
7:35	First rally of 5 minutes on wedges.
7:45	Second rally of 5 minutes on wedges.

7:55	Third rally of 5 minutes on wedges. Toggles between sliding ways and ribbands removed by each berth gang after completion of third rally. Pour one pint of oil in each space left by removal of grease plates.
8:00	Start splitting keel blocks, removing necessary cribbing.
8:45	All keel blocks out except last twelve, observe and report all creeping.
9:00	Start removing forward keel blocks, stop when creeping exceeds ½ inch. Remove dog shores; all men out from under vessel.
9:12	Start burning tie plates.
9:15	Plates burned, vessel starts.

Senate Merchant Marine Hearings

(*Concluded from page 220.*)

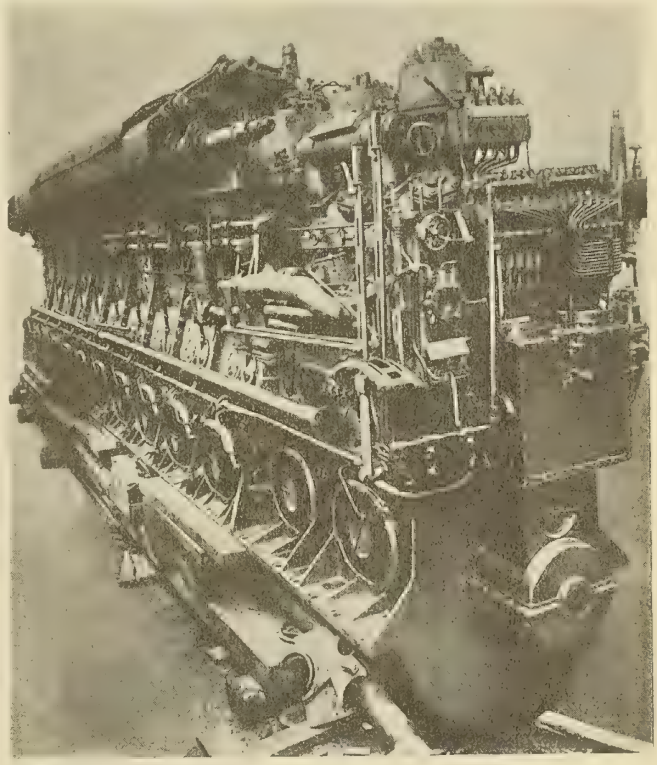
owners in the United States, if offered on terms of 25 percent down and the balance in 15 or 20 years. The Munson executive was, however, very pessimistic as to the possibility of the Government effecting a sale of the 400 wooden vessels on hand. His idea of the best way out of a bad bargain with respect to these wooden ships was to charter the vessels—that is, allow the Shipping Board to charter them on a bare boat basis, prorating that among the ones who had bought or invested their capital in the ships which are now owned by the Government. At a guess, Mr. Munson figured that, by reason of present surplus in the hands of United States ship corporations and money set aside out of earnings in the past ten years for the purchase of building of ships, there is, at the present time, an agregate of perhaps $150,000,000 (£30,800,000) to $200,000,000 (£41,000,000) awaiting investment in ships which would be available for first payments upon Government tonnage should the latter be offered at prices and terms to attract buyers.

This witness combated emphatically the theory that had been advanced to the committee that if the Government vessels were sold control would pass to Wall street. "I do not think," said Mr. Munson, "there is any chance of Wall street ever getting control over the American merchant marine. I am a great believer in the old adage that competition is the life of trade, and I believe if the Shipping Board disposes of all its vessels within the next six months we will see lower rates than we have had in five years." The speaker declared that he felt very strongly that the Government, through the Shipping Board, would be performing a constructive service were it to help the small operators—that is, the modest interests among the 190 operators of vessels under the Emergency Fleet Corporation, to get on their feet and develop organizations as independent ship operators, a status that, in his judgment, they can attain only in the event that they are given the benefit of favorable terms for the acquisition of vessels.

Asked whether the effect of a liberal policy in the disposition of the Government's fleet would be to bring into the field permanently new ship operating interests, Mr. Munson answered emphatically in the affirmative, adding: "I believe that of the 190 operating companies under the Shipping Board today you will find that at least half, not owning a boat today of any kind, would be investing, particularly if the scheme be carried out for Government help in the actual financing of the vessels ordered in American yards." His idea of Federal aid was not confined, either to the disposition of vessels now in the hands of the Government. Rather would the Shipping Board lend moral and financial support to legitimate American ship operating companies that may hereafter desire to order vessels direct from the shipbuilders. This would be accomplished by the Shipping Board saying to the shipowner, as the witness phrased it: "You pay 25 percent down to the shipbuilder and we will take a mortgage on your vessel and you can make the balance of the payments on your vessel to us." The advantage of such an operating plan, as Mr. Munson senses it, is that it would result in the specification of ships of special design for use in special trades which, within the knowledge of the shipowner making the contract, would almost certainly prove profitable.

German Submarine Cruisers

JUST before the armistice, the Germans had practically completed the construction of the first of the submarine cruisers which had been designed some time previously. These boats had a surface displacement of about 2,100 tons and a submerged displacement of 2,600 tons.



3,000 Brake Horsepower, Ten-Cylinder German Submarine Diesel Engine

They were about 305 feet in length, with a beam of 30 feet and a draft of 17 feet.

Although none of them appears to have been put into commission, they are of considerable interest, especially from the point of view of the machinery installation, which is the largest ever contemplated for a Diesel-driven submarine. Two oil engines, each of 3,000 brake horsepower, were used, and an illustration is given of one of these motors, which is by far the highest-powered, high-speed Diesel engine that has ever been constructed for marine purposes. It has ten cylinders with a diameter and a stroke of 20.87 inches (530 millimeters) each and it is designed for an output of 3,000 brake horsepower at just under 400 revolutions per minute, the mean effective pressure in the cylinders being 117 pounds per square inch.

The engine is directly reversible, and maneuvering is controlled by the two vertical levers seen in front of the engine. It is of the four-cycle construction, as employed in the majority of German submarine engines, and, apart from its size, embodies no new principles in Diesel engine design. Two air compressors are fitted at the after end of the engine, and these can be seen in the illustration.

It was anticipated that a speed of about 17 knots would be attained with these boats.

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A Warning

A COWARDLY attempt to benefit by the high standing of this magazine is being made by a publication, issued across the border, which is distributing circulars conveying the impression that they emanated from the office of Marine Engineering. We caution our advertisers and subscribers not to be caught by this camouflaged bait, for they will get a very cheap, poor imitation of the real Marine Engineering.

"National Marine Week Stands for American Independence on the Sea—What Do You Stand For?"

WITH the above as a slogan, the National Marine League appeals to the maritime interests of the country in behalf of the exposition to be held in the Grand Central Palace, New York, during the week of April 12 to 17. The appeal is made to advertisers in marine publications to exhibit their products, and already two floors of the big exposition building have been taken for this purpose. More exhibitors are wanted, however, and if the exhibition could be made unanimous, it would be a tremendously effective piece of propaganda for the American shipping industries.

The League has begun the promotion of a national publicity campaign to start the American public thinking seriously upon the problems and possibilities of our merchant marine, and National Marine Week is intended to be a high point in the work. In brief, the National Marine League has undertaken to arouse the people themselves to think in terms of ships and to realize that American cargoes, mails and passengers carried in ships built, owned, operated and manned by Americans, ships classified and insured by American companies, ships equipped and repaired by American industry, are vitally important to the welfare and prosperity of the American nation.

Of the need of the work there can be no doubt, and that the programme of the League is well adapted to carrying out the work is the conclusion of the many able men who have studied the task. The League will gladly receive suggestions along these lines from every American who has our maritime interests at heart. There is room for all, and all are welcome. Will you help?

The Motor Boat Show

THAT the popularity of motor boating as a sport and its usefulness as a commercial industry have not suffered on account of the inactivity in this direction during the war is shown by the enthusiastic attendance and the extent and variety of the exhibits at the fifteenth annual Motor Boat Show, which was held in New York during the last week in February. The experience many young men gained in naval service during the war has served not only to arouse greater interest than ever before in motor boating as a sport but also to create a widespread demand for power craft which possess greater seaworthiness. The straight-line, high-speed pleasure boats are rapidly giving way to vessels with fuller models, sturdier commercial types of engines and ample protection for the helmsman to permit bad weather cruising. Other tendencies which were noticeable in the exhibits were the more general adoption of standardized fittings and the increased popularity of heavy oil engines using a type of fuel less expensive than gasoline (petrol).

Merchant Marine Hearings in Washington

AS pointed out in our last issue, the testimony being presented before the Senate Committee on Commerce in regard to a permanent policy for the merchant marine is conflicting in the extreme. On the one hand representatives of shipbuilding companies and delegates from organizations of shipyard workers are urging the continuance of the present sales policy of the Shipping Board, maintaining prices at more than $200 (41/13/4) a deadweight ton, while, on the other hand, representatives of some of the largest steamship companies in the country are advocating the sale of government ships within a short period at a price around $100 (20/16/8) a deadweight ton, together with exemption from excess taxes, as a measure to enable American shipping to compete successfully with foreign lines. Except for the shipyard workers, who favor reconsideration of cancellations of government contracts and further building for government account, the general opinion is that the government should divorce itself from shipbuilding and shipowning activities as speedily as possible, so that these twin industries may be placed under private control for future development without delay.

The shipowners, apparently, are sincere in their belief that $100 (20/16/8) a ton represents a price for the government-owned cargo ships that cannot be exceeded if American shipowners are to have anything like a fair and even chance in competition with existing foreign tonnage. H. H. Raymond, president of the American Steamship

Owners' Association, points out that steel cargo steamers, similar in type and most of them probably of greater actual value than the ships of our government emergency fleet, could have been, and were, constructed in this country before the war for about $70 (14/11/8) a deadweight ton. There were relatively few of these vessels in our merchant marine before the war, but there were thousands of such ships in the merchant fleets of Great Britain, Germany, Norway, France, Holland, Italy and Japan. In fact, some of these steamers were built abroad before the war at a price as low as $40 (8/6/8) a ton. Great Britain, after all her war losses, still possesses upwards of 20,000,000 deadweight tons of ships that were in service before the war, and the average cost of these vessels, most of which are still serviceable, was well below $60 (12/10/0) a ton. The high profits of the war period have probably enabled most of the British shipowners to mark their existing tonnage down to a merely nominal valuation. It is with this relatively low-cost shipping of the world's pre-war fleets that the high-cost steamers of the Shipping Board must go into close competition.

To show the handicap under which American shipowners would be placed in such competition, if they are forced to pay from $220 (45/16/8) to $225 (46/17/6) a deadweight ton for their ships, Mr. Raymond gives a comparison of the charges on the capital invested in two similar vessels of 10,000 deadweight tons, one furnished to British shipowners by the British government at a cost of $100 (20/16/8) per ton, and the other furnished to American shipowners by the Shipping Board at a price of $220 (45/16/8) a ton. The difference in favor of the British vessel based on the three essential factors of insurance, depreciation and interest would be equivalent to 15.6 percent on the cost of the British vessel, while the difference in the cost of wages of officers and crew in favor of the British vessel would probably not be over 20 to 30 percent. As remedies for these conditions, the shipowners suggest that, to offset the difference in charges on capital investment, the government should write down the cost of its vessels to $100 (20/16/8) a deadweight ton, and to equalize the difference in wage cost, which is a relatively small and probably decreasing factor, an allowance of 10 percent of the net earnings of American ships should be granted on account of depreciation, and the amount deducted as operating expenses in the tax returns. They further suggest that for the important purpose of directly encouraging American shipbuilding ships bought from the Shipping Board and kept under the American flag be exempted from Federal excess profits taxes on condition that an amount equivalent to such exemption be invested by the owner in the purchase of additional tonnage constructed in American yards.

Isherwood System of Ship Construction

Of the many developments which have been made in methods of ship construction during the past twelve years, probably none has had such a far-reaching effect, or been so widely adopted, as the Isherwood system of longitudinal framing. During the twelve years since this system was introduced, nearly 1,300 vessels, totaling 10,573,550 tons deadweight carrying capacity, have been built or are now under construction on the Isherwood system. The following table, showing the number and deadweight tonnage of Isherwood ships built since the system was introduced, serves as a barometer, not only of the Isherwood system itself but of the fluctuating phases of shipbuilding in general throughout the world during this twelve-year period:

Year	Number of Ships	Deadweight Tonnage
Sept., 1907-Dec., 1908	6	31,608
1909	30	181,384
1910	40	271,760
1911	64	474,043
1912	100	618,553
1913	30	215,686
1914	41	358,288
1915	157	1,196,899
1916	152	1,117,779
1917	180	1,655,693
1918	250	2,364,778
1919	210	1,887,079
Totals	1,260	10,573,550

Classifying these vessels according to types, the number of general cargo vessels, colliers, ore steamers, passenger steamships and Great Lake freighters built on the Isherwood system titaled 658, aggregating 5,935,692 tons deadweight carrying capacity. The oil tank steamers totaled 509, aggregating 4,585,608 tons deadweight carrying capacity, and the barges, dredgers and trawlers totaled 93, aggregating 52,250 tons deadweight carrying capacity.

During the year 1919 there were on the ways at the various shipyards of Great Britain and the United States more than 400 ships of the Isherwood type. Among these vessels there were no less than 150 oil tankers, which, when finished, will be capable of transporting over 8,000,000 tons of fuel oil during the year. Incidentally, these 150 tankers—many of them over 10,000 tons deadweight capacity—comprise the whole of the world's contracts for oil tankers given out in 1919. Today there are no fewer than 509 oil tankers built and building on the Isherwood system, and those which were afloat during the war carried the major portion of the oil required by the Allies for land and sea service.

Shortly after the conclusion of the armistice, it was estimated that during 1920 there would be a world deficit of at least one million tons of oil-carrying shipping as against the demands for oil fuel supplies. That this estimate was to all intents and purposes an accurate gage of the year's requirements is shown by the fact that the leading oil companies are now ordering tankers in unprecedented numbers, all under high-pressure construction orders, from the principal shipyards in this country, in Great Britain and on the Continent. It is significant that a very large percentage of the orders for the tankers has gone to American shipyards. With the contemplated additions during the present year there will be afloat towards the close of 1920 more than 4,500,000 tons deadweight of Isherwood type vessels devoted to carrying nearly the whole of the world's oil supplies.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Value of the Ejector

Mr. F. C. Getliffe's letter on page 71 of the January issue interested me very much, for some years ago I was in a ship that almost foundered, due to the pumps becoming choked with coal dust that had run into the bilges. However, "a miss is as good as a mile." We did not go down, but if we had had an ejector as suggested by your correspondent, lots of hard labor and anxiety would have been saved us during that voyage.

Briefly, this is what happened. We were laden with bag sugar from British Guiana, South America, bound for Philadelphia, Pa., where the raw sugar was to be refined. We were laden very deep—in fact, to the limit. When off Hatteras we ran into a storm (it was in March) and the ship tumbled around considerably, although so deeply laden. Our midship coal bunker had been emptied, excepting for the usual sweepings which remained, and the water in the bilge during the rolling dislodged the bunker flooring, which, strange as it may appear, had not been secured to the framing and keelsons of the ship. Of course, what coal there was in that bunker ran down into the bilge, through the limbers, into the engine room bilge, and very soon choked up the rose boxes or strainers and soon put the engine bilge pumps out of business. The water was black with coal dust.

After the engine pumps gave out we started up the independent donkey pump, which had a 6-inch suction. The rose box of that pump also soon got choked up, and the valves in the pump as well. However, that was the only pump we had for the purpose, and, of course, we did not want to resort to the bilge injection, unless it were a case of life or death, so the firemen took turns at keeping the rose box clear, while the engineers kept the pump valves working.

This pump was on the port side of the ship, and when the ship rolled to port the water was so deep that we could do nothing in the way of keeping strainer and pump valves clear. When the ship rolled to starboard, the port side was fairly free from water, so we hastily cleared the rose box and cleared out the pump valves (by taking off and putting on, alternately, the value chest cover of the water end, which, temporarily, we secured with two nuts only) while the ship was in that position.

This procedure was kept up for a whole day without cessation. We just about managed to keep the water from gaining, and nothing to spare. The water was cold, as might be expected at that time of the year, and all hands were pretty well used up. However, we ran out of the storm during the third day, and when the ship ceased rolling violently we soon cleared all the pumps and got rid of the water in a short while.

Now, if we only had had an ejector as described by Mr. Getliffe we would have mastered the situation with much less trouble, and in less time. Not any of us thought about an ejector at the time, but even if we had, there was not anything on board with which to make a "home-made" ejector, nor did we have the pipe tools with which to make such a device. I am strongly of the opinion that every ship should have both *ejectors* and *injectors,* just for possible emergencies that may arise. Many steam power plants on land have both these valuable pieces of apparatus for possible emergencies. They are not expensive to install and they have no parts that are liable to get out of order very quickly.

Brooklyn, N. Y. CHARLES J. MASON.

"Pointing Off" When Using the Slide Rule

The hardest thing for a beginner to learn about the operation of a slide rule is to keep track of his decimal point.

The method used in long-hand, of starting at the right and point off to the left, will not work at all on a slide rule, as the entire number of figures is not always known, due to the fact that the average rule can be read to only three or four places.

The following rule does not take into consideration the figures to the right of the decimal point except in the case of fractions. It is very simple and is so short that it can be marked on the back of your slide rule and therefore does not even have to be memorized.

It is:

Sum of the Characteristics	<—— Multiplication ——>	Sum of the Characteristics minus 1
Difference of the Characteristics	<—— Division ——>	Difference of the Characteristics plus 1

The arrow indicating the direction the slide is pointing.

The characteristic of a whole number is the number of digits to the left of the decimal point. Thus the characteristic of 25.74 is plus 2. The characteristic of a fraction is the number of zeros between the decimal point and the first significant figure. Thus .2574 has a characteristic of plus or minus 0, for there are no digits to the left of the decimal point and there are no zeros between the decimal point and the first significant figure, while .0002574 has a characteristic of minus 3, for there are three zeros between the decimal point and 2, the first significant figure.

When the sum or the difference of the characteristics of two figures is to be obtained, it should always be the algebraic sum. Thus, 2 plus (minus 3) equals minus 1, or 2 minus (minus 3) equals plus 5.

Take, for example, $25.74 \times .0682$. The characteristic of 25.74 is plus 2, and that of .0682 is minus 1. The slide extends to the left, and, as this is multiplication, it should be the sum of the characteristics. Hence, plus 2 plus (minus 1) equals plus 1, which means that the answer will contain one digit to the left of the decimal point or 1.76.

Suppose that this had been division, that is, 25.74 divided by .0682, the characteristics of both members remain the same. The slide still extends to the left, but as this is division it is the difference of the characteristics,

or plus 2 minus (minus 1) equals plus 3, and the answer becomes 377.4.

Take another example of multiplication: .1268 × 71.5. The slide extends to the right so the rule says sum of the characteristics minus 1. The characteristic of .1268 is 0, and that of 71.5 is plus 2. The sum is plus 2 plus 0 equals plus 2, but it is the sum minus 1, or plus 2 minus 1 equals plus 1, and the answer is 9.06.

Another example of division: .00925 divided by 12.5. The characteristic of .00925 is minus 2, and that of 12.5 is plus 2. The slide extends to the right, and, as this is division, the rule says the difference of the characteristics plus 1, or minus 2 plus (minus 2) equals minus 4, but it is the difference plus 1, or minus 4 plus 1 equals minus 3 and the answer is .00074.

Any number of examples might be given, but as these four cover every possible use of the rule the reader is left to practice with examples of his own manufacture.

Jacksonville, Fla. B. W. Manier.

Shipwrecked at the Dock in a Typhoon

While sailing the Seven Seas it has been my good fortune to weather many a bad storm, and so to have my narrowest escape from shipwreck and sudden death occur while loading cargo in the port of Hong Kong may seem strange, to say the least.

We had been lying-to for several days, together with some four hundred and fifty other vessels, making the most of good weather to unload or take on another cargo before clearing for home. On the morning of September 6, 1906, our ship, of 8,700 deadweight tons, was nearly loaded, when out of an apparently clear sky a terrific typhoon struck us. The fires in the boilers had been banked two or three days before, so when we tried to get up steam in a hurry to keep the ship headed into the wind we failed hopelessly. As a result, even with three anchors out, we piled up against the dock and nearly wrecked the Custom House.

When the typhoon had blown itself out the harbor of Hong Kong presented a rather chaotic appearance. About $10,000,000 (£2,050,000) damage had been done and over 1,200 lives lost.

The fact that no previous warning of the storm had been given seemed a rather strange occurrence for a port of the importance of Hong Kong. It was later discovered that the observatories at Shanghai and Hong Kong were in the midst of a private feud and were not on such terms that weather reports might be exchanged.

Views of Damage to Shipping in Hong Kong Harbor Caused by Typhoon in 1906

Swapping yarns some time after the disaster with another engineer who had been in the port at the time, he declared that he was half tempted to connect the engines of his ship to one of the ventilators when he found that he could not get up steam in time to keep them off shore.

G. J. L.

Removing a Key

I read your paper every month and like it very much. I like the letters best, as I am learning the machinist's trade and so get ideas from the letters.

A man who has been at the trade for more than twenty years told me he never saw a key got out the way my boss got one out, so I thought I would write you about it.

My boss is Lem Baker and I have worked with him for

six months. We had to take the coupling off an eight-inch shaft. Lem and a helper and I started to do the work, but instead of trying to drift out the key with a sledge, Lem filed the end of the key on top to a taper, where it stuck out about an inch, taking off about an eighth at the end. Next he got a very narrow cape chisel and chipped down each side of the key at its end, back about a quarter, close to the sides of the key way. Then he used the drift, the helper doing the striking, and the key came out easy because the end did not upset all the time we were drifting.

The man who had been at the trade twenty years said it was just common sense, which many people do not have in the machinist trade.

New London, Conn. James Murray.

Nut-Holding Device

This little trick can be employed to good advantage by any mechanic, therefore I pass it along. When putting in or taking out bolts and nuts in restricted places in and about machinery parts, it is sometimes necessary to employ a

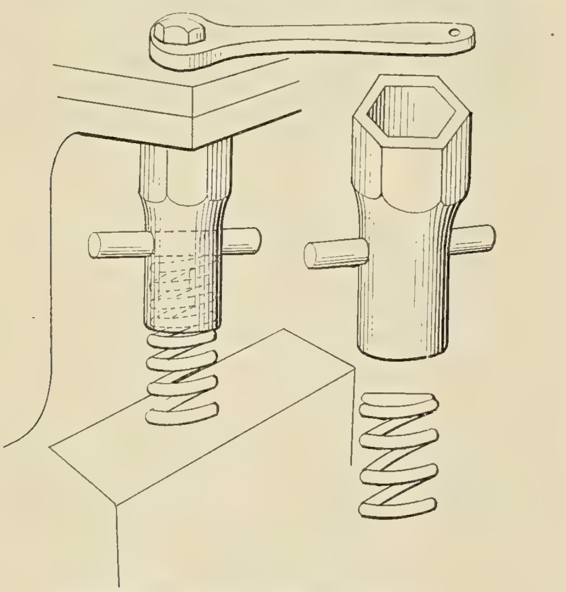


Fig. 1.—Sketch of Nut-Holding Device

helper to hold the bolt from turning while tightening the nut. By making a short length socket wrench from a piece of steel tubing or pipe and putting a short rod through it, as shown in Fig. I, and obtaining a spring that will fit in the pipe and force the wrench in place, you will have a little device that is equal to a helper for this work.

A block of wood is used to build up the distance under the spring when not possible to set it directly against a machine part. The rod in the socket wrench brings up against the casting or adjacent part of the machine, thus holding the wrench from turning.

Concord, N. H. C. H. Willey.

Designating Machine Finish

There has come to my attention a system that a certain drafting room uses to designate the grade of "finish" which they desire on machine parts. In this system the symbol ordinarily used for "finish" is given a power or exponent, such as f^1 or f^2, etc. These small figures placed to the right, a little above the ordinary finish mark, determine the certain class of finish desired, as shown in Fig. 1.

In order that the workman in the shop may correctly understand the meaning of the finish mark exponents,

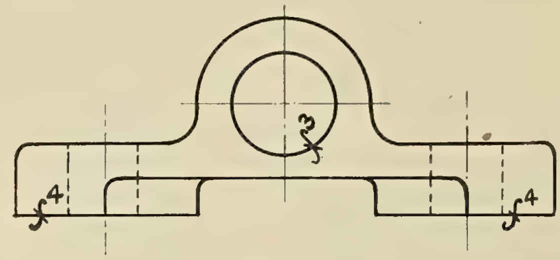


Fig. 1

their definition is stamped on the tracing in the drafting room, so that on each print which goes to the shop there is included the following key, or table:

Key to Finishes

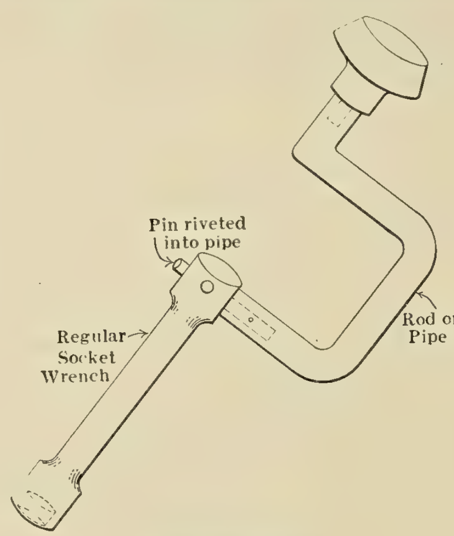
f^1—Water-cooled grind or lap.
f^2—Dry machine grind.
f^3—Smooth machine.
f^4—Finishing cut.
f^5—Rough cut.
f^6—Hand grind or file.

Thus a draftsman can very easily and conveniently express in a simple manner the particular quality of finish he wants on any surface of a machine part.

Portsmouth, Va. Peter Petrovsky.

Socket Wrench Crank

Quite often one meets with a job that requires the removal and replacing of many nuts of the same size. Much time can be saved if a special brace wrench can be used. When it is not possible to find such a wrench at hand, a socket wrench can be used by making an attachment, consisting of a crank made of pipe or tubing with



Improvised Brace

a short piece of rod to fit the hole through the socket wrench end, and a knob to fit in as a breast plate. The idea is conveyed better in the illustration than words can describe it. Machinist's Mate.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Preliminary Computations for Marine Steam Engine

Q. (1032).—Given the following data for a triple-expansion marine engine: 26-inch by 43-inch by 71-inch cylinders and 48-inch stroke; boiler pressure, 180 pounds gage; cut-off, .67, .67 and .63 respectively on the high-, intermediate- and low-pressure cylinders; diameter of piston rod, 7½ inches; revolutions per minute, 80; factor for probable mean effective pressure, .70.

Please work out the ratio of expansion; mean effective pressure; actual mean effective pressure referred to low-pressure cylinder; indicated horsepower; mean effective pressure in each cylinder assuming equal work; terminal pressure in each cylinder at cut-off; and steam admitted per stroke. Kindly give formulas. M. B.

A. (1032).—In making a preliminary calculation for the dimensions of an engine, it is customary to neglect the size of piston rod when considering the cylinder sizes. It is also supposed that the cylinder dimensions will be obtained from their ratios to the high-pressure cylinder, which would be given in the data together with cut-off, indicated horsepower, piston speed, and factor for mean effective pressure. Below you will find the calculations as commonly carried out in a preliminary computation (i. e., area of the piston rod neglected); the results in the parentheses show the effect of allowing for the piston rod, which should be considered in a careful computation of strength or power, as, for instance, finding the indicated horsepower of an engine in existence when the cards have been obtained.

Number of expansions:

$$n = cR = \frac{1}{.67} \times \frac{\pi/4\,(71)^2}{\pi/4\,(26)^2} = 11.1. \qquad (11.5)$$

Mean effective pressure referred to low-pressure cylinder:

$$M.\,E.\,P. = P_1 \frac{1}{h}(1 + \log_e n) - P_2.$$

$$= \frac{194.7}{11.1}(1 + 2.408) - 5.0.$$

$$= 59.8 - 5.0 = 54.8. \qquad (53.0 \text{ pounds})$$

Probable mean effective pressure referred to low-pressure cylinder:

$$\text{Probable } M.\,E.\,P. = .70\ M.\,E.\,P.$$

$$= .70 \times 54.8 = 38.4 \text{ pounds.} \qquad (37.1 \text{ pounds})$$

Mean effective pressure, each cylinder for equal work:

$$L.\,P. = \frac{38.4}{3} = 12.8 \text{ pounds.} \qquad (12.4 \text{ pounds})$$

$$I.\,P. = 12.8 \times \frac{\pi/4\,(71)^2}{\pi/4\,(43)^2} = 34.9 \text{ pounds.} \qquad (34.1 \text{ pounds})$$

$$H.\,P. = 12.8 \times \frac{\pi/4\,(71)^2}{\pi/4\,(26)^2} = 95.3 \text{ pounds.} \qquad (95.8 \text{ pounds})$$

Theoretical pressure in each cylinder at cut-off:

$$(H.\,P.)\ P_1 = P_1 \frac{C_h}{C_1} \times \frac{D_h}{D_1}$$

$$= 194.7\left(\frac{.67}{.67}\right) \times \frac{\pi/4\,(26)^2}{\pi/4\,(43)^2} = 71.4 \text{ pounds.} \qquad (69.3 \text{ pounds})$$

$$(I.\,P.)\ P_c = 194.7\left(\frac{.67}{.63}\right) \times \frac{\pi/4\,(26)^2}{\pi/4\,(71)^2} = 27.8 \text{ pounds.} \qquad (26.8 \text{ pounds})$$

Steam volume of high-pressure cylinder at cut-off, assuming no clearance:

$$\text{Volume} = \frac{\pi d^2}{4} \times \frac{4 \times .67}{.144} = 9.89 \text{ cubic feet of steam per stroke.} \qquad (9.47 \text{ cubic feet})$$

The weight of steam admitted at each stroke can be approximated, if we assume the steam dry and look up the specific volume of steam at the cut-off pressure.

Safety Valve Problem

Q. (1034).—Will you kindly figure the following problem as closely as possible: Diameter of valve, 2½ inches; pressure, 81 pounds; distance of valve from fulcrum, 3 inches; weight of lever, 3 pounds; one-half length of lever, 12 inches; weight of valve and stem, 3 pounds; length of lever, 24 inches.

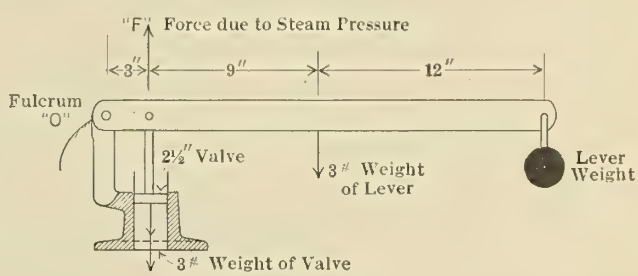
Find lever weight. B. B.

A. (1034).—The steam pressure will exert the force F determined as indicated below:

Area over which the steam acts is that of a 2½-inch circle, or

$$\pi \frac{d^2}{4} = \frac{3.14}{4} \times \frac{25}{4} = 4.91 \text{ square inches.}$$

Force $F = 4.91 \times 81 = 397$ pounds.



We will now take moments of all the forces about the fulcrum O in the figure:

Anti-clockwise moment $= 397 \times 3 = 1{,}191$ inch-pounds.

Clockwise moments—
- Moment of valve and stem $= 3 \times 3 = 9$ inch-pounds.
- Moment of weight of lever $= 3 \times 12 = 36$ inch-pounds.
- Moment of lever weight $= 24 \times W = 24W$ inch-pounds.
- Total clockwise moments $= 45 + 24W$ inch-pounds.

It is clear that for the safety valve to be on the point of lifting, the anti-clockwise moments and the clockwise moments about O must be equal. If we equate same, we can now solve, for the value of W, the lever weight:

$$45 + 24W = 1{,}191.$$

$$W = \frac{1{,}191 - 45}{24} = \frac{1{,}146}{24} = 47.7 \text{ pounds (weight required at end of lever).}$$

We have here assumed that it was intended to place the weight at the end of the lever. Should it be desired to locate it at some other distance from the fulcrum O, the solution can be carried out by replacing the arm 24 inches by the above distance.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

GULF COAST SHIPYARDS SEE PROSPERITY AHEAD

Southern Concerns Full of Business, With Big Mobile Plant Booked Up for Years on British Contracts—Launchings of a Ship a Month Expected.

British capital, says a Mobile, Ala., authority, has offered to the Mobile Shipbuilding Company a contract for the construction of between twenty and twenty-five bulk oil carriers, which will require two years to fill. The efficiency of the plant is being increased so that ships can be turned out faster, and H. L. Brittain, president of the Mobile Shipbuilding Company and the Birmingham, Ala., Steel Corporation, announces that plans are being made to increase the output of the concern between 25 and 40 percent within the next few months.

Mr. Brittain, who is in close touch with shipbuilding concerns all over the country, because of his position as one of the five shipbuilders on the general committee which meets with five international presidents to fix all wages, hours and conditions in the various shipbuilding plants of the country, stated that all the big concerns of the country had work in sight to take their output for the next five years.

"Contracts now let or under negotiation by the Moshico plant will consume the capacity of the local plant for the next four or five years," he said. "The Mobile Shipbuilding Company is here to stay, and it must be reckoned as one of the great industrial concerns of the city.

"Provided the material situation does not get so bad that we can't get out steel requirements," said Mr. Brittain, "ships will be built here in ever-increasing numbers. The Birmingham plant has been held up on account of steel, and our present contracts are in the same fix. The situation will take a better turn soon, I hope, and then we may figure on future work."

No Let-Up At the Yards

"There will be no let-up in the yards here," declared Mr. Brittain. "We shall operate to the end of this year on contracts already placed with us, and not on contracts still ungained. The programme for 1920 is pretty well mapped out. We intend to finish all our work for the Emergency Fleet Corporation before January 1, 1921, and to close the year here with the construction of ships for private shippers and foreign companies.

"All our ships will be oil burning in the future. The five ships now on the ways will burn fuel oil, and so will the two already launched. Oil has just been received for the dock trial of the *Minooka*, and we expect a still larger shipment of oil so that she may make her sea trial within the next two weeks. The *Hutchinson*, the other ship now on the equipping dock, is twenty days behind the *Minooka*, but she too should be turned over about the first of March.

More Men, More Business

"A considerable increase will be made in the operating force employed at Moshico. It is now a question with us of taking the business most profitable to the yards. What we want is to have the Moshico do larger business for a longer period of time. The demand now is enormous for oil tankers, and we shall concentrate our efforts on the construction of those. England is coming over here to place her contracts for oil tankers, and every big concern has been offered one of these British contracts."

Mr. Brittain added that as the concern was now reaching the point where it could turn out a 5,000-ton ship a month, the cost of each, as well as the time taken for construction, was being reduced. He also said that probably two or three standard types of ships would be built, and these alone.

"The demand for ships," he concluded, "is as great now as during the time when the German submarines were operating. The Government is not demanding them, it is the private concerns. We are not called on to make so many in so short a time, but everything we can turn out will be taken."

Mobile Launchings Scheduled

Ten ships are on ways in Mobile having a tonnage of 70,300, an increase of 10,000 tons over the tonnage launched during the entire year of 1919. At the Chickasaw Company's yard, the *Birmingham City* will be launched this month, and a celebration will be held at that time. February 17 has been named as a tentative date. The next of the three ships now on the ways at Chickasaw to be launched will be the *Mobile City*.

Five steel ships are under construction at Moshico. The *Oklahoma City* will be the only one launched this month, while the *Capital of Nebraska* will be the next. The aim of the Mobile Shipbuilding Company is to launch one of their new ships every month.

So much work remains to be done on the *Marei* at the Alabama Company's plant that it may be March before the vessel is launched. Officials of the company state that it is much easier and less expensive to install the machinery before the vessel goes into the water.

PASSENGER SHIP PLANS

Porto Rico, Red D and Munson Lines May Build

Plans for passenger ships for the New York & Porto Rico Steamship Company, 11 Broadway, the Red D Line, 82 Wall street, and the Munson Steamship Line, 82 Beaver street, are nearing completion, according to an announcement this week, and it is understood that the shipbuilders will be asked to submit bids for the vessels at an early date. According to reports, the Red D Line is planning to have two 5,000-ton passenger ships, having a speed of about 14 or 15 knots, built.

It has been known that the New York & Porto Rico Line was figuring on at least two oil-burning passenger liners for service to the West Indies. The ships are to be about 400 feet long, and are to be fitted out with luxurious appointments.

Little information can be obtained regarding the two vessels projected for the Munson Steamship Line. It is generally understood that they will be designed to meet tropical requirements.

The plans for all six ships are being drawn up by Theodore Ferris, according to shipbuilders. The companies concerned are reluctant to talk regarding passenger ships, and generally state that they will not build unless prices are reasonable enough to warrant construction.

Building Eight Steamers at New Orleans

The steamer *New Orleans*, launched late in January at the yards of the Doullut & Williams Shipbuilding Company, New Orleans, La., was the first of eight vessels to be built by the yard for the Shipping Board Emergency Fleet Corporation. Three others will be launched at intervals of thirty days each.

HOG ISLAND'S RECORD IN AMERICAN SHIP BUILDING

What Has Been Accomplished at the Great Plant Since Work Began in September, 1917—More Than 660,000 Tons Launched

While there has been considerable discussion as to the great plant of the American International Shipbuilding Corporation at Hog Island, Pa., few people are fully aware of the remarkable record made there since construction began. The following illuminating figures are supplied to SHIPS AND SHIPPING by Mr. M. C. Brush, president of the corporation, and are a valuable addition to the record of American shipbuilding. They complete the record to January 31, 1920:

Contract signed	September 13, 1917	
Actual construction begun	September 20, 1917	
First keel laid	February 12, 1918	
First ship launched	August 5, 1918	
World launching record of 5 ships in 48 minutes, 10 seconds	May 30, 1919	
Area of Hog Island	927 acres	
Number of ways	50	
Number of piers	7 (1,000 ft. long and 100 ft. wide)	
Number of men employed	22,000	
Number of rivets driven to date	54,113,839	
Length of water front, miles	2¼	
Length of railroad tracks, miles	82	
Number of warehouses	36	
Floor space of all buildings, acres	103	
Number of concerns who furnished supplies to construct yard	3,500	
Lumber used	150,000,000 feet	
Piles driven	151,000	
Amount of water filtered and chlorinated	1,300,000 gallons daily	
Length of water piping	29 miles	
Length of sewers and drains	26 miles	
Length of wiring	675 miles	
Length of telephone wiring	3,000 miles	
Capacity of load—compressed air	74,000 cubic feet	
83 Ships launched to date with highest rating of Lloyd's and American Bureau. Total deadweight tons	660,175	
70 Ships delivered to date with highest rating of Lloyd's and American Bureau. Total deadweight tons	547,750	
Which have steamed over 1,000,000 miles and carried over 800,000 tons of cargo.		
Total tonnage launched, "A"—1919	485,150 D. W. tons	517,150
Total tonnage launched, "B"—1919	32,000 D. W. tons	
Total tonnage delivered—1919	500,800 D. W. tons	
Total working days	278 1/5	
Total working hours	2,228	
D. W. tons launched per 8-hour day	1,850	
D. W. tons delivered per 8-hour day	1,798	

One ship launched every 4¼ working days, or 34 working hours.
One ship delivered every 4⅓ working days, or 35 working hours.

CITY TAKES TERMINAL

Long Island City Will Have Big Public Dock

The new State barge canal terminal at Nott avenue and the East River, Long Island City, has been taken over from the contractors by Edward Walsh, New York State Superintendent of Public Works, and as soon as the necessary men to operate it can be obtained it will be available for use.

Commissioner Walsh plans to throw the terminal open to the manufacturers and business men of the district for use as a public dock. State canal barges will be landed there as well as all the shipping the manufacturers may have. Two harbor masters will be appointed, to be in charge of the terminals, and the equipment for the expeditious and economical handling of freight is said to be up to the minute in completeness.

Pascagoula to Build Steel

To meet changed conditions following the close of the war, the building of wooden ships has been abandoned at the plant of the International Shipbuilding Company at Pascagoula, Miss., for a time at least The building of steel ships will continue at the plant without interruption, it has been stated by one of the officers of the company.

It is claimed that the building of wooden ships, with the present high price of labor and material, has been carried on at a loss, and therefore, until conditions change, will be dropped for a time. There is one wooden ship on the ways at the yard now, and this will be completed.

20,000-TON TANKERS

Standard Oil Company of New Jersey Orders Two

The Standard Oil Company of New Jersey, 26 Broadway, has just placed a contract with the Newport News Dry Dock & Shipbuilding Company for two 20,000-ton tankers. These will be the largest tankers in the world, the largest afloat to-day being of 18,500 deadweight tons. Before the war the largest tankers were about 15,000 tons, all built with Isherwood framing.

It is also reported, but not confirmed, that a duplicate order has been placed with the Sparrows Point plant of the Bethlehem Shipbuilding Corporation, Ltd.

To Build Molasses Tankers

The Staten Island Shipbuilding Company has received contracts for two molasses tankers, of 6,300 deadweight tons each, from the American Sugar Refining Company of New Jersey, 117 Wall street, this city.

DELAWARE RIVER WORK

Hog Island the Only Yard Without Orders Far Ahead

In a description of the Delaware River shipbuilding district, which he speaks of as the permanently established shipbuilding centre of the world, a writer in the Philadelphia North American, presents a cheerful forecast for the next year, saying that all the yards except Hog Island have orders far ahead. He continues:

Shipworkers in the Philadelphia district are assured of continuous employment, without reductions in force, for more than a year ahead. At only one of the Delaware River shipyards is there any doubt as to the labor demands of the immediate future. That doubt surrounds Hog Island, whose contract with the Emergency Fleet Corporation will have been completed by mid-summer. It employs more than 20,000 workmen.

The management of every other shipyard of the district are unanimous in an optimistic outlook for the industry. Orders are actually on hand to keep the yards at capacity for months; in instances the yard facilities and working forces have been increased, and further expansions will be necessary as soon as foreign exchange becomes stabilized and starts its march towards normal.

The New York Shipbuilding Corporation, at Camden, now lays claim to being the world's largest, completely equipped shipbuilding yard. At the time of the armistice it had 13,500 men on its operating force; this force within recent months has been reorganized and increased to 19,000 men. Contracts on hand guarantee capacity employment for the remainder of the year.

The optimism of the Sun Shipbuilding Corporation, at Chester, is materially illustrated by the fact that two new ways are under construction to help care for the great mass of work scheduled, which will keep between 6,000 and 7,000 men busy for at least two and one-half years. The new ways will be done by July, when the keels for two ships immediately will be laid upon them.

The Merchant Shipbuilding Corporation, with yards at Bristol and at Chester, report sufficient work to keep the present force running at full capacity for another year and a half. Two 12,500-ton freighters and four 10,500-ton tankers are under actual contract for private concerns at Chester. The company additionally has under order from the Emergency Fleet Corporation eleven fabricated ships, of which the keels have not as yet been laid for four.

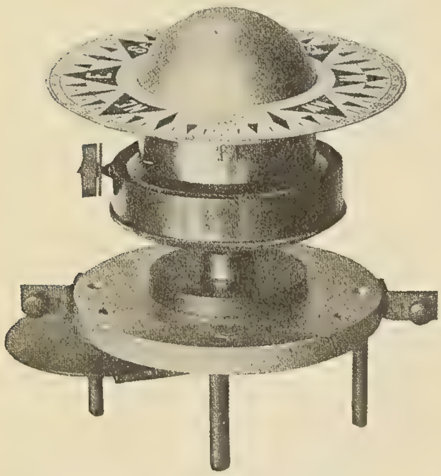
Nor is the Pusey & Jones Company, of Gloucester, in the least behind its sister yards. Contracts are under way to keep 4,000 workmen busy for the remainder of the year, while English contracts are being taken for two years ahead of this date. Five ships will be completed here in August, closing out the Emergency Fleet contract.

IMPROVED APPLIANCES

New Non-Magnetic Compass Invented

A compass which is non-magnetic and does not depend on gyroscopic action for its pole-finding properties is being exhibited by R. E. Bibbins, at Room 1722, 150 Nassau street, New York City.

The device consists of two separate units—a steel vessel and a ball. The vessel floats freely around a vertical guide while the ball which is contained in the vessel is rotated at high velocity by a stream of compressed air led into the vessel and impelled against the side of the ball. A nozzle, made of agate to resist wear, is placed in the bottom of the cup, to render the direction of air-flow constant. Because of this fact, the ball rotates on an imaginary axis, while



New Non-Magnetic Compass
Earth's Motion Reproduced

it is floated in an air gap free of all connection with the containing vessel. If the propelling air is properly adjusted to the correct spin of the ball, the motion of the earth is simulated; that is, the current of air passes around an equator while the ball rotates on its imaginary axis.

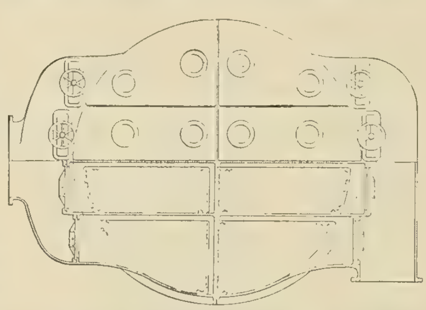
In setting up this compass for navigation, surveying or similar purposes, the device is so adjusted that the revolution of the ball in the line of its equator corresponds closely to the rotation of the earth from west to east. It follows that the axis of the ball, being at right angles to this rotation, runs due north and south. In other words, the axis of the ball and the compass card attached to the vessel indicates the meridian of the locality in which the compass is located.

As long as the stream of air is supplied to the chamber, the ball will continue to rotate in the line of its equator unless some outside force is supplied to displace the compass temporarily from its normal position.

In explanation of the ability of this compass to indicate true north at all times, the inventors state that the daily revolution of the earth on its axis and the revolution of the air-driven ball are in the same plane when the axis of the ball is coincident with the meredian. This daily revolution exerts a constant tendency to tip the supporting vessel, like everything else on the earth's surface, so that it will perform the same revolution in space as the earth does, and with the same angular velocity as the earth. The ball, however, does not partake of this tipping to the same extent as the vessel, if at all, being disconnected from the vessel (it is floating in the air gap). Gravity is counterbalanced by the supporting force of the air which drives the ball. The angular velocity depends naturally upon the force of the stream of air which impinges on its side. When this is properly attuned to the size and weight of the ball and other features of the device, a force is exerted against the pull of the earth to tip the vessel, tending to maintain the position of the ball on the meridian. The resultant of these two forces (the rotation of the ball and the tipping tendency of the earth) is a single force which turns the vessel around the vertical air guide instead of tipping it away from the rotating ball. This force manifests itself in a procession of the compass, which does not stop until its position in the line of the meridian has been regained.

New Type of Condenser

A recent development in steam surface condensers has been announced by the Wheeler Condenser & Engineering Company, of Carteret, N. J. It is a compartment condenser which may be cleaned while in service without interrupting the operation of the turbines. To accomplish this cleaning any of the tubes may be temporarily plugged without interfering with the action of those



Cross-Section of New Wheeler Compartment Condenser

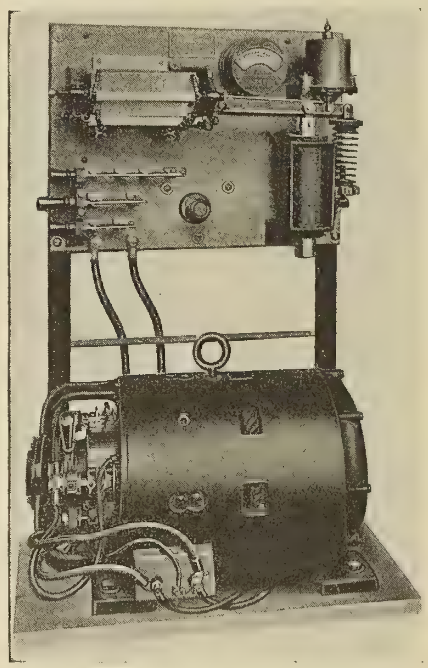
remaining. That the condenser be kept clean is essential in maintaining a high vacuum, which ultimately means low fuel consumption.

The condenser shown is divided into four compartments, each compartment being equipped with a set of valves to control the circulating water. To clean the condenser while the turbine is delivering full power, the operator simply shuts off the water from one compartment, removes the cover, cleans the tubes, replaces the cover, turns on the water again and then passes on to the next compartment.

Plastic Arc Welding Unit

A plastic arc welding unit has recently been supplied by the Wilson Welder & Metals Company, 2 Rector street, New York city.

The set is composed of a dynamotor, having a flat compound-wound generator maintaining a normal average of 35 feet at all loads, and a current-control panel. The Wilson principle of constant welding steel is utilized. To accomplish this, a small carbon pile, a



Wilson Welding and Metals Company
Plastic Art Welding Unit

compression spring and a solenoid working in opposition to the spring are mounted on the control panel. The solenoid is in series with the arc so that any variation in the current will cause the solenoid to vary the pressure on the carbon pile. thus keeping the current at its adjusted value. Constant currents, ranging from 25 amperes to 175 amperes, are possible.

Various standard motor characteristics are available as a dynamotor unit; 110 volts, 220 volts, direct current; 220 volts, 440 volts, 60 cycle, two or three-phase alternating current. It may also be obtained in a gasoline (petrol) belt-drive without the motor.

Ship's Safe That Floats

One of the most novel exhibits at the recent Shipping, Engineering and Machinery Exhibition in London was that of a floating ship's safe such as used by the Netherlands Government for the conveyance of mails and valuables to and from their colonies. It automatically disconnects itself from a sinking ship, and while floating in the water sends up a rocket every hour for twelve hours. A sound signal is also given and a light shown for three months from the moment it leaves the ship.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIP CONTRACTS

The France & Canada Steamship Company, 120 Broadway, New York, is reported to be in the market for six 10,000-ton tankers.

Freighter, Wilmington, Del.—The Pusey & Jones yard has laid the keel for a 2,750-ton freighter, 265 feet over all, for the Eastern Steamship Company, of Boston, Mass.

Tankers, Sparrows Point, Md.—It is reported that the Standard Oil Company has placed an order for two 20,000-ton tankers with the Bethlehem Shipbuilding Corporation.

Tankers, Newport News, Va.—The Standard Oil Company of New Jersey has just placed a contract with the Newport News Shipbuilding & Dry Dock Company for two 20,000-ton tankers.

Tankers, Gloucester City, N. J.—The Shell Transport Company of London has awarded a contract for four 8,500-ton tankers to the Pusey & Jones Shipbuilding Company, Gloucester City, N. J.

Wooden Boats, Norfolk, Va.—Norfolk Shipyards, Inc., capital $10,000, Benjamin Lowenberg, president, Norfolk; L. M. Bailey, secretary, Portsmouth, Va., has been organized to build wooden boats.

Tankers, Port Richmond, S. I.—The Staten Island Shipbuilding Company has received a contract for building two molasses tankers of 6,300 deadweight tons each from the American Sugar Refining Company.

Tankers, Camden, N. J.—Three 12,500-ton tankers have been ordered by the Standard Oil Company of New York from the New York Shipbuilding Company. They will be built at the Camden, N. J., yards.

Tankers, New York.—The Atlantic, Gulf & West Indies Steamship Lines, 11 Broadway, is in the market for six more bulk oil carriers of 9,600 tons deadweight in addition to those already under contract of construction.

Overhauling Destroyers, New London, Conn.—The New London Ship & Engine Company has purchased the United States destroyers Reid, Flusser, Preston and Lamson, and will overhaul them and install Diesel engines.

Big Tanker Programme. — The Scottish-American Oil & Transport Company of London, England, is forming a subsidiary company called Tankers, Ltd., with a capital of £5,000,000 and a big programme for building bulk oil carriers.

Schooners, Portland, Ore.—Two six-masted schooners of 4,150 deadweight tons each, built by the Peninsula Shipbuilding Company of Portland, Ore., have been sold to Grant Smith, of Portland, who will finish them for use in the lumber trade.

Colliers, Gloucester City, N. J.—The Pusey & Jones Company has a contract for fourteen colliers. Work was recently started there on three 8,500-ton tankers for French owners. Four other ships are on the ways, one of which is nearing the launching stage.

Schooners, Milton, Fla.—The Milton, Fla., shipyard recently purchased by Pascagoula, Miss., interests, is to finish the uncompleted schooner on the ways, and will make a specialty of building three-masted vessels for the coastwise and West Indies trade.

Steel Ships, Pascagoula, Miss.—The International Shipbuilding Company of Pascagoula, Miss., will finish one wooden ship now on the ways and discontinue building wooden hulls. The building of steel ships will continue at the plant without interruption.

Steamer St. Louis to Be Reconditioned.—The International Mercantile Marine, 9 Broadway, announces that the steamer St. Louis, now at the yards of W. & A. Fletcher, Hoboken, will be raised, reconditioned and take her place in the transatlantic trade.

Tankers, Chester, Penn.—The Merchant Shipbuilding Corporation, 165 Broadway, New York, has received an order from the Union Oil Company, of California, for two 10,000-ton bulk oil carriers. They will be built at the Chester, Penn., yards of the corporation.

Schooners, Milton, Fla.—The shipyard at Milton, Fla., recently purchased by Pascagoula interests, is soon to be opened and worked to its full capacity on three-masted schooners for the coastwise and West Indian trade. An uncompleted schooner now on the ways will be finished.

Concrete Boats, Norfolk, Va.—The Norfolk Construction & Marine Repair Corporation will erect a complete repair yard, with three railways and equipment for the construction of concrete barges and scows. The new concern has taken over the assets and holdings of the National Concrete Boat Company.

Freight Steamer, Quebec. — The Davis Shipbuilding Company has been awarded a contract by the Dominion Government for the construction of an 8,350-ton steel freight vessel, to be added to the Canadian merchant marine. Under construction is a large pontoon for the Canada Steamship Lines.

Repairing Former Virginian.—The former Allen liner Virginian, purchased in London a short time ago by the Swedish-American Line, Nielsen & Lundbeck, 24 State street, New York agents, has been renamed the Drottingholm, and will undergo extensive repairs in a British port, involving an expenditure of $100,000.

Converting Composite Ships, Savannah, Ga.—Four incomplete composite ships at the Terry Shipbuilding Company's yards, Port Wentworth, Savannah, are being converted into all-steel cargo carriers. Their length will be increased 45 feet, their tonnage increased from 3,500 to 4,200 tons, and oil substituted for coal as fuel.

Refrigerator Ships, Newark, N. J.—Among the contracts which the Submarine Boat Corporation, 5 Nassau street, New York, is putting through at the Newark Bay Yards is one for refrigerator ships for the International Products Company, 120 Broadway. Two of these, it is reported, are under way and will be of 1,400 gross tons.

New Steamship Company, Portland Me.—William H. Burton, formerly president and general manager of the Maine Coast Company, purchased the steamers Massasoit and Mohawk of that concern. He has organized a new company to be known as the Kennebec Steamship Company, maintaining two services, one to Portland and another to Jonesport, Me.

Tanker, Oakland, Cal.—The Standard Oil Company of California has contracted with the Moore Shipbuilding Company for an oil tanker with a capacity of 45,000 barrels, to be equipped with twin Diesel engines of 850 horsepower each of the type built by the Skandia Pacific Company. This will be the largest Diesel-driven ship every built in the United States.

Repairing Steamer, Oakland, Cal. — The Moore Shipbuilding Company has been awarded the contract for repairing the damaged stern of the steamer Howick Hall. The entire stern will be torn out and replaced, and the work will require at least two months. The damage resulted when several huge seas struck the vessel after she cleared the port for the Orient.

Cargo Ships, Long Beach Shipbuilding Company, Long Beach, Cal.—The keel for the second ship of the California & Mexico Steamship Company, San Francisco, has just been laid in the Craig Shipyards, Long Beach, Cal., and a third vessel has been ordered. The new ship will be the same as the Mazatlan, the first of the fleet being completed for the California & Mexico Steamship Company.

Repairing Steamers. — Contracts for repairs on five Shipping Board vessels have been placed as follows: The Ascoda, Vulcan Iron Works, Jersey City, N. J.; the Western City, Tebo's Yacht Basin, Brooklyn; the Lorain, Robins Dry Dock & Repair Company, Brooklyn; the Lake George, Marine Iron Works, Brooklyn, and the Lake Fackler, Arthur Tickle Engineering Company, Brooklyn.

Overhauling Destroyers, New London, Conn.—The New London Ship & Engine Company has purchased the United States destroyers Reid, Flusser, Preston and Lamson from the T. A. Scott Company, of New London, which recently purchased them from the Government. The company will give them a thorough overhauling and install Diesel engines, after which they will be sold to some foreign country.

Tankers, Chester, Penn.—Four tank steamers, each of 12,000 deadweight tons, have been ordered by the Atlantic, Gulf & West Indies Steamship Lines from the Sun Shipbuilding Company, of Chester, Pa. The company is planning a floating loading station about 85 miles south of Tampico, Mexico, which will enable two tankers to load at the same time. A 400-foot wooden pier is to be constructed to accommodate barges.

Steamship Companies, British Columbia, Canada.—The Vancouver Steamship Company, Ltd., and The Western Canada Steamships, Ltd., were recently incorporated under the laws of British Columbia by men representing eastern and western capital. Each will build an 8,300-deadweight tons standard steel freight carrier, at the yards of Coughlin & Sons, Vancouver, and will operate the ships on trans-Pacific routes out of Vancouver.

Changing to Oil Burners, San Francisco, Cal.—Work has begun at the Union Plant of the Bethlehem Shipbuilding Corporation,

Ltd., on changing the 8,000 gross tons steamer Tahiti, of the Union Steamship Company, of Dunedin, N. Z., from a coal to an oil burner. Two other ships of the line will be overhauled and converted as soon as possible. It is believed that every vessel of the Union Line fleet, 59 in all, will be converted to oil burners.

Tankers, Mobile, Ala.—The Mobile Shipbuilding Company, it is announced by H. L. Brittain, president of the company, has received an order for between twenty and twenty-five bulk oil carriers from British interests. The specifications are not given, but it will take two years to complete the contract. The capacity of the plant will be largely increased, more men will be employed, and it is intended to turn out a 5,000-ton ship every month.

Cargo Ships and Tankers, Pensacola, Fla.—It is announced that a contract for building eight 9,000-ton ships and two 13,000-ton tankers has been made by the Government with the Pensacola Shipbuilding Company, the contract to start about April 1, when the company's original contract for ships for the Emergency Fleet Corporation has been completed. Information as to structural details of the ships and their engines has not been made public.

Converting Wooden Hulls, Seattle, Wash.—The wooden hull, Acadamea, one of the wooden freight carriers in Lake Union, near Seattle, Wash., has been purchased by Bruce C. Shorts, of Seattle, for $35,000. He will convert the craft into a steam schooner. Five hulls in Gray's Harbor, Wash., have been sold to the National Oil Company of New York, and will be taken to San Francisco to have machinery installed. The purchase price for the hulls was $350,000.

Passenger Steamers.—The New York & Porto Rico Steamship Company, 11 Broadway, New York, is planning to have two passenger ships, about 400 feet in length, built. The Red D Line, 82 Wall street, New York, is planning for two passenger ships of 5,000 tons and 14 or 15 knots speed, and the Munson Line, 82 Beaver street, New York, is also in line for two passenger steamers, built to meet tropical requirements. They will all be Ferris type boats, according to announcements.

Steam Schooner, Portland, Ore. — The Charles R. McCormick Lumber Company will stretch the keel of another big lumber schooner at the St. Helens Shipbuilding Company's yards as soon as the city of Everett, launched February 4, has made her trial trip. The new ship, like the City of Everett, will be equipped with engines developing 1,400 horsepower, with twin screws. It is understood that if a change in specifications will produce a more desirable vessel, plans for additional boats will be altered.

Freight Steamers, San Francisco, Cal.—The Moore Shipbuilding Company, at Oakland, Cal., has begun work on two 14,000-ton freight carriers for the Matson Navigation Company, San Francisco. They will carry 14,000 tons of sugar each, and 6,000-horsepower engines, with turbine geared propeller shafts, will develop a speed of 12½ knots loaded. The Matson Company is also working out details and specifications for a steamer to be the largest, fastest and most palatial passenger vessel on the Pacific.

The American Ship Building Company, Cleveland, has uncompleted orders for twenty vessels. Its subsidiary companies have the following orders for delivery early next spring: The Great Lakes Engineering Works, Detroit, will build seven; the Toledo Shipbuilding Company, four; the Manitowoc Shipbuilding Company, seven; the Saginaw Shipbuilding Company, six; the McDougall-Duluth Company, eight, and the Globe Shipbuilding Company, five. The McDougall-Duluth Company also has started construction of five other vessels for private concerns.

Freight Steamer, Seattle, Wash.—J. F. Duthie & Company have received a contract from the Coastwise Steamship & Barge Company for the construction of a 2,350-ton steel steamship for service in the coal, ore and lumber carrying trade in Puget Sound, British Columbia and Alaskan waters. The ship is to be delivered in June. It will be 220 feet long, 40 feet beam, with a molded depth of 21 feet. The engines will be aft, and she will have a loaded speed of 11 knots. She will be able to carry 1,500,000 feet of lumber. This is the first steel ship contracted for on private account in Seattle since the war ended.

SHIPBUILDING AND REPAIR PLANTS

Concrete Ship Plant, Mobile, Ala.—Fred T. Ley & Company, of Mobile, plan the purchase of the plant they are now operating from the Emergency Fleet Corporation.

Ship Repair Plant, St. Petersburg, Fla.—J. W. Attley, president, and J. B. White, secretary, have organized the Marine Ways Machine Company, Inc.; capital, $25,000.

Drydock, Locust Point, Md.—The Coastwise Shipbuilding Company is making plans for excavating for a dock 380 feet long and with a lifting capacity of 6,000 deadweight tons.

Drydock, Astoria, Ore.—The Port of Astoria Commission is having preliminary plans prepared for a drydock to cost about $1,000,000. R. R. Bartlett, Astoria, Ore, is engineer in charge.

New Shipyard, Portland, Me.—The National Oil Transport Company has been incorporated to build barges, ships, etc., with $1,000,000 capital, by R. I. Johnson, H. J. Smith and A. B. Farnham.

Drydock, Hoboken, N. J.—The first section of three which will make an 8,500-ton drydock being built at Bayonne by the W. & A. Fletcher Company, of Hoboken, has been launched. The dock when completed will cost about $800,000.

Drydock, St. Helenss, Ore.—The Charles R. McCormick Lumber Company has nearly completed its new dock at St. Helens. Tracks for the traveling cranes are to be laid from the dock to the plant of the St. Helens Shipbuilding Company.

New Shipyard, Kittery, Me.—The Boston Maritime Corporation has been incorporated, with $2,000,000 capital, to engage in shipbuilding in all its branches. The incorporators are Harry W. Foster, George W. Burnham and Elmer J. Burnham.

New Shipyard, Baltimore, Md.—The Globe Shipbuilding & Dry Dock Company (noted in February issue) is preparing plans to include construction of drydocks, ship berths, railroad switches and various buildings. Estimated cost about $5,000,000.

Drydock, Brooklyn, N. Y.—The fourth section of a Todd Shipyards Corporation 9,000-ton floating drydock will be put in operation this spring. The dock will be 432 feet long, 114 feet wide and will accommodate ships 500 feet in length and 26 in draft.

Drydock, New London, Conn.—It is planned to build a drydock in connection with the port development. The Mayor of New London has appointed a committee to act in conjunction with civic bodies and labor organizations in support of the project.

Drydock, Sparrows Point, Md.—The Bethlehem Shipbuilding Corporation will lay the keel for a floating drydock in April. The work is being delayed pending the completion of pontoons now being constructed. When completed the drydock will be capable of receiving a 400-foot ship of 6,000 deadweight tons.

Drydock Company Merger, Providence, R. I.—The Lord Drydock Company has made an offer to the Marine Dry Dock & Engineering Company to take over the plant and continue the business of the latter company, with the object of consolidating and strengthening the position of the plants in Providence and New York City.

Ship Yard to Be Naval Base, San Diego, Cal.—The Scofield Engineering Company's shipyard at San Diego, Cal., has been turned over by the Shipping Board to the Navy Department. It will be converted into a fleet repair base, accommodating vessels up to 3,000 tons. Rear Admiral R. W. Wells will be in charge.

New Shipyard, Norfolk, Va.—The Norfolk Construction & Marine Repair Company is to erect one of the most complete repair yards in its district, comprising three railways of 500, 1,200 and 3,000 tons, respectively, and ways and equipment for the construction of concrete barges and scows. The company has about half a mile of water front on the southern branch of the Elizabeth River, and about 60 acres of land. Work will begin soon. Col. M. A. Butler, at present in charge of the Army Base at Norfolk, will assume control of the new concern on March 15.

Ship Repair Plant, Boston, Mass.—J. L. Byrne, 53 State street, Boston, is planning a ship repair plant to occupy about 14 acres at the entrance to Chelsea Creek. Two 10,000-ton drydocks (convertible into one 12,000-ton dock), one 8,000-ton, one 3,200-ton sectional floating dock and one 500-ton floating drydock are to be constructed, with wet basins and a complete equipment of shops. Wharves, piers and buildings will be largely of concrete. Mechanical equipment of shops to be electrically driven. Dredging has begun and the project is expected to be completed in about nine months.

PORT IMPROVEMENTS

Wharf, Pittsburg, Cal.—The city has voted to issue $40,000 in bonds to build a wharf. Information from city clerk.

Dredging, Cleveland, Ohio.—United States Engineer's Office, Federal building, Cleveland, is having plans prepared for dredging in Huron harbor; about $35,000.

Underwater Bracing, Baltimore, Md.—The Superintendent of Lighthouses will receive bids for installing new underwater bracing at York Spit Light Station, Virginia. Information on application.

Repairing Pier and Breakwater, Dunkirk, N. Y.—The United States Engineer's Office, 540 Federal building, Buffalo, is having plans prepared for repairing the west pier and breakwater, Dunkirk harbor.

Terminal, South Boston, Mass.—The Eastern Terminal Company, J. E. Starr, 103 Federal street, New London, Conn., has purchased site and plans to build terminal storehouse; cost, about $2,000,000; engineer not selected.

Dredging, Galveston, Tex.—Bids will be received until March 11 by the United States Engineer's Office, Trust Company building, Postoffice and Tremont street, for dredging Houston Ship Channel. Information on application.

Municipal Pier, Baltimore.—Bancfort Hill, president of the Harbor Board, is working out details of plans for new bulkhead and municipal pier in the Locust Point section. Several acres of land are being reclaimed for this purpose.

Docking and Repairing Light Vessel, Charleston, S. C.—Bids will be received by the Superintendent of Lighthouses, Charleston, S. C., for docking and repairing Brunswick Light Vessel No. 84. Information on application.

Stone for Jetties, San Francisco, Cal.—The United States Engineer's Office, Washington, D. C., will soon reecive bids for furnishing stone for jetty structures at Humboldt Harbor and Bay. Former bids rejected. Noted in February issue.

Rock Supply, New Orleans.—The Superintendent of Lighthouses, New Orleans, La., will soon receive bids for furnishing and delivering in place around Horn Island Light Station, Mississippi, about 400 tons ballast or other approved rock.

Dredging, Norfolk, Va.—The United States Engineer's Office, War Department, Washington, D. C., has let contract for dredging in Pagan River, Norfolk, to W. H. French Dredging & Wrecking Company, Arcade building; cost, $6,806.

Heating Piers, New York.—Fruit importers in New York are endeavoring to have piers on which food products are handled supplied with heat. They assert that large quantities of perishable foodstuffs are lost every year through freezing on the piers.

Dredging Harbor, San Diego, Cal.—The War Department has awarded a contract for dredging more than 1,500,000 cubic yards from the various shoal areas in the harbor of San Diego, Cal., to the United States Dredging Company, San Francisco.

Lighthouse Tender, New Orleans, La.—The Superintendent of Lighthouses, New Orleans, La., will reecive bids for furnishing labor and material to completely construct, equip and deliver 65-foot twin-screw lighthouse tender Aster. Information on application.

Dredging, Hudson River Channel, N. Y.—The United States Engineer's Office, 39 Whitehall street, New York, has let contract for dredging in Hudson River Channel, New York harbor, to F. E. Jones, 17 Battery Place, New York, for about $375,000.

Repairing Pier, Santa Monica, Cal.—The city will receive bids for repairing municipal pleasure pier, to have creosoted wooden piles to support the deck, etc. About $75,000 available. Olmstead & Gillellen, Hollingsworth building, Los Angeles, engineers.

Dredging and Rock Removal, Hudson River, N. Y.—Bids will be received until March 11 by the United States Engineer's Office, Army building, 39 Whitehall street, New York, for dredging and rock removal in Hudson River, N. Y. Information on application.

Army Piers, Norfolk, Va.—The City of Norfolk has taken over, under contract with the War Department, a portion of the Army Supply Base, and is operating Pier No. 2. The piers have a draft of 40 feet at low tide with ample storage space and railroad service.

New Harbor, Stockton, Cal.—The City Council has had preliminary plans prepared for a new harbor, involving widening the channel from 200 to 1,250 feet, building wharves, etc.; cost estimated about $4,000,000. S. A. Judd, Stockton, engineer; A. L. Banks, city clerk.

Repairs to Light Vessel, Charleston, S. C.—Bids will be received by the Superintendent of Lighthouses, Charleston, S. C., until February 26 for manufacturing one new cast iron condenser body and main engine back columns, for Frying Pan Shoals Light Vessel No. 94. Information on application.

Municipal Dock, Vancouver, Wash.—Detailed plans for the proposed municipal dock for Vancouver, Wash., have been made public. The dock will be 1,245 feet long and 200 feet wide. It is planned to cover 800 feet of the dock, which will cost about $365,000. The first unit will cost about $150,000.

Ship Terminal, Berkeley, Cal.—The Pacific Port Terminal Company, F. F. Cresson, Jr., 50 Church street, New York City, engineer, plans to build a ship terminal at Berkeley, Cal., to include piers, bulkheads, sheds, one-story warehouse, railroads, etc., on water front. Estimated cost about $2,000,000.

Piers and Warehouses, Marshfield, Ore.—Coos Bay authorities are planning locations for port docks and warehouses. The Pony Inlet district, just west of the North Bend, is regarded as the most available site, but will require a vast amount of dredging to make a channel deep enough for maneuvering vessels.

Piers, Staten Island, N. Y.—The Board of Estimate, New York City, has increased the appropriation for dredging and the construction and equipment of proposed piers at Stapleton, Staten Island. Former bids above amount allotted. Murray Hulbert, Commissioner of Docks, Pier A, New York City, in charge.

Terminal, Vancouver, B. C.—The Dominion Government has completed the purchase of 750 feet of water frontage for a terminal site. A new pier to be erected this year will be just west of the Great Northern dock. The Government dock with equipment, including site, will cost $4,400,000, it is announced.

Sea Wall, Paris Island, S. C.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., has plans, and will soon receive bids, for building 2,062 lineal feet of concrete sea wall and other concrete work at the marine barracks. Estimated $86,000; $10 deposit required for plans and specifications.

Piers, Providence, R. I.—Tentative plans are being developed by Jonathan Starr, New London, Conn., representing the Eastern Terminal Corporation, for three 1,000-foot piers, a terminal warehouse and trackage connection with the New York, New Haven & Hartford Railroad at Harbor Junction, South Providence, R. I.

Channel, Marshfield, Ore.—The State of Oregon has had preliminary plans prepared by A. Powers, Oregon Agricultural College, Corvallis, for building channel 4,000 feet long, 30 feet wide, 6 feet deep at low water, 60 feet deep at highest point to connect Isthmus Inlet and Beavers Slough; estimated cost about $125,000.

Deepening Newark Bay.—The New Jersey Port Development Association has been organized, with Calvin Tomkins, former Commissioner of Docks, New York City, as president, for the purpose of deepening Newark Bay and converting the waste meadow land along the bay into sites for manufacturing concerns and railroad terminals.

Terminals, Pascagoula, Miss.—The city of Pascagoula intends to spend between $75,000 and $85,000 on terminals, and the order for piling for a 500-foot wharf, which will cost $40,000, has already been given. A spur track of the Louisville & Nashville Railroad will run from the wharf to the yards of the International Shipbuilding Company.

Bunkers, Portland, Ore.—The Commission of Public Docks has authorized G. B. Hegardt, chief engineer for the commission, to prepare plans and specifications for the erection of bunkers at the St. Johns terminal, suitable for the handling of coal, sulphur or other similar material in bulk. The bunkers will probably be built on Pier 5 of the terminal.

Dredging, Detroit, Mich. — The United States Engineer's Office, Railroad building, has let contract for dredging and rock excavating in Livingston Channel, Detroit River, involving 98,000 cubic yards of limestone rock, and 345,000 yards place measurement of earth to the Empire Engineering Company, Inc., 6 Church street, New York, at $600,760.

Piers, Camden, N. J.—Under a bond issue of $500,000 work on two piers at Camden, N. J., will begin as soon as weather conditions permit. Contracts have been let. The northern pier will accommodate ships 600 feet in length, and the southern pier ships of 480 feet length. The plans also call for a big marine terminal, the entire project to involve $3,000,000.

Terminal, Long Island City, N. Y.—The new State barge canal terminal at Nott avenue and the East River has been taken over from the contractors by Edward Walsh, New York State Superintendent of Public Works, who intends to throw the terminal open to manufacturers and business men in the district for use as a public dock as soon as the men necessary to operate it can be obtained.

Channels, Long Beach, Cal.—J. F. Collins, City Harbor Engineer, has recommended that the city widen and deepen channels and turning basin, extend jetties and construct wharves; estimated cost $2,496,390. Two alternative plans suggested, one, not including extension of jetties, to cost $1,443,350; the other, not including widening two channels, to cost $1,904,500. H. C. Waughop, city clerk.

Wharfage and Storage Space, New Orleans, La.—The Secretary of War has approved the application of the Director General of Railroads for the use of 900 linear feet of wharfage and 50,000 square feet of storage space at the Army Supply Base, New Orleans, La., for the barge line operated by the Mississippi-Warrior River Section, Division of Inland Waterways, United States Railroad Administration.

Submarine Base, Key West, Fla.—Contract for constructing the Key West Submarine Base, involving building of breakwater and a number of timber piers, dredging, etc., has been awarded to the Snare & Triest Company. of New York, partly on a unit price and partly on a lump sum basis. Total estimated cost, $1,700,000. The Bowers Southern Dredging Company, Galveston, has the contract for dredging.

Port Improvement, New Orleans, La.—The Board of Commissioners of the Port of New Orleans intends to expend about $14,500,000 in improvements in 1920. This includes $5,000,000 for construction of new wharves, improvements on existing wharves and betterment of port facilities; $2,000,000 will be used in rat-proofing wharves, wharf approaches, landings and warehouses, and $7,500,000 on completion of the Industrial Canal. The work of rat-proofing has just begun under urgent orders from the Commission.

Fuel Oil Stations.—Thirteen fuel oil stations have been located by the Shipping Board. One at St. Thomas, Virgin Islands, of 110,000-barrel capacity, and another at Brest, France, of 165,000-barrel capacity, are now in operation. Others at Ponta Delgada, Azores, Cape Verde Islands, Bizerta, Algiers, Constantinople, Colombo, Shanghai and Manila are expected to be ready by April 1. At Honolulu a 110,000-barrel supply is to be ready by June 1. At Durban, South Africa, a 165,000-barrel capacity, and at Sydney, N. S. W., a supply not yet determined are expected to be ready by July 1.

Piers, Seattle, Wash.—The Seattle Port Commission's Smith Cove Pier B, said to be the most gigantic of the world's ocean piers, was to be opened about February 15. Chief Engineer George F. Nicholson, who designed Pier B, announced that its superstructure or wharf is 90 percent completed, while the decking is progressing rapidly. The pier is 2,54$ feet long and 267 feet wide, and with ease will be able to handle 1,800,000 tons a year. This pier represents an expenditure of $2,500,000. Although it will not be ready for regular operation until May 1, Capt. Inar A. Pederson, traffic manager of the Port Commission, has ordered that the first ship should start loading the middle of February.

FOREIGN MARITIME MATTERS

Breakwater, Port Maitland, N. S.—The Department of Public Works, Ottawa, plans to build a stone-filled native timber crib breakwater at Port Maitland. Cost, about $200,000. C. E. W. Dadwell is the district engineer.

Docks, Dairen, Manchuria.—Extension of a quay line to make possible berthing of 15,000 tons of shipping and the handling of 12,000,000 tons of cargo a year is planned by the Manchuria Railway Company. The work will extend over a period of ten years.

Drydock, St. John, N. B.—Machinery and power equipment for the plant of the St. John Dry Dock & Shipbuilding Company, at Courtenay Bay, N. B., are arriving and being stored preparatory to beginning work, which will start as soon as weather conditions permit.

The Southern Steamship Company, Ltd., of Newcastle-on-Tyne, England, has sold its fleet of 11 vessels, aggregating 76,000 tons, to the Western Counties Shipping Company, of Cardiff, Wales, for £1,900,000. The buyers recently purchased the fleet of the Moor Line, of Newcastle.

Passenger Steamer, Belfast.—The new steamer which Harland & Wolff are building at Belfast for the Aberdeen Line passenger service to Australia is to be a geared turbine oil burner of 12,000 tons. A second vessel of this type is to be built for the same company at once.

New Steamship Company, Antwerp.—Plans are announced for the founding of a new steamship company, to be known as the Compagnie du Sud Franco-Belge, of Antwerp, which will operate vessels under the Belgian flag between Antwerp and ports of Brazil and Argentina.

J. C. Gould & Company, Ltd., Cardiff, Wales, have issued details of a plan for the formation of a new company, with a capital of £3,000,000, in £1 shares, to acquire the Griffiths-Lewis Steam Navigation Company, Ltd., and the Dulcia Steam Shipping Company, Ltd., of Cardiff.

Enlarging Danzig Harbor, Germany.—Danzig harbor is to be dredged and enlarged at an expense of 2,500,000 marks. On the east of the Kaiser dock a quay is being built 1,000 meters long. Warehouses and a harbor for steamers are projected on the west side of the Vistula River.

Shipping Merger, Cardiff, Wales.—The Hansen Shipping Company, Ltd., of Cardiff, is to acquire the controlling interest in Graham's Navigation & Collieries, Ltd. T. C. Graham, Henry J. Thomas and Arthur W. Graham will retire from the Graham directorate as soon as the transfer is completed.

Ships Needed, Brazil.—Dr. Cincinnato Braza, Minister of Agriculture, Industry and Commerce, announces that it will be necessary for Brazil to spend an enormous amount of money in the near future for ships, and that at least 500,000 tons of river and ocean steamships will be needed by Brazil within the next generation.

German Shipping Lines Combined.—The Deutsche-Levante Linie and the Hamburg-America Linie have made an agreement according to which the assets of the former are to pass to the latter as a whole without liquidation. The service is to be continued under the name of Deutsche-Levante Linie and under the same flag.

Harbor Improvements, Kingston, Ont.—The Dominion Government plans to dredge outer entrance of harbor works and enlarge basin to 25 feet. The project includes a complete layout railway trackage and yards, dock and grain elevator, with a capacity of 2,400,000 bushels. W. A. Bowden, Department of Railways and Canals, Ottawa, Ont., engineer in charge.

Canada to Aid Shipyards.—The Dominion Government has decided to make loans to Pacific Coast shipyards up to 75 percent of the cost of each ship under construction. The Chilberg Ship Company of Victoria, B. C., will build four wooden sailing schooners, the government lending the project up to $175,000 a ship, with the company furnishing $75,000.

Oil Bunkering, Liverpool.—The Mersey Docks and Harbor Board will open the "Parkhill and Dingle Bank Estates" at the south end of the dock estate, for the erection of oil storage tanks for bunkering and other purposes at Liverpool. The tanks will have pipe lines to oil berths in the Herculaneum Branch Dock, where vessels can use their own pumps to discharge to the tanks.

Repairing Quay Walls, Glasgow, Scotland.—The Clyde Trustees are preparing to undertake a good many minor improvements, and also to repair the damage caused to quay walls in different parts of the harbor. Work has already begun on the Anderson Quay. The estimated cost of reconstruction is figured at £50,000. Work will soon ha e to be undertaken at the Plantation Quay on the opposite side of the river.

Motor Vessels, Copenhagen, Denmark.—The East Asiatic Company, of Copenhagen, has decided to build 17 vessels of from 10,000 to 13,000 tons deadweight each, to be completed in the next three or four years. The largest will have two 3,200-horsepower Diesel engines, giving a speed of 14 knots and will be ready for trial this year. If this ship is satisfactory, it is stated, motor vessels of up to 15,000 to 16,000 tons and 6,000 horsepower will be built.

Vickers & Company are making extensions to their Yarrow shipyard, to enable them to overtake the large programme of merchant shipbuilding. The company is now building two Cunard liners, two for the Commonwealth Government, a Donaldson liner, an oil tanker and other similar vessels, and is preparing three large new berths. It has also taken over the yard of the Ferro-Concrete Ship Construction Company, which has abandoned the construction of concrete vessels.

New Shipyard, Kiel, Germany.—The now Commonwealth Shipyard at Kiel, which embraces the former Imperial yard, will be under the Ministry of the Treasury and handled by a joint stock company in which all the shares are owned by the State. The yard has begun to build merchant vessels, and four 8,800-ton turbine-driven ships are to be built for the Rob M. Sloman Company, while the Commonwealth Commisioner has ordered 20 fishing steamers and a number of Baltic and North Sea fishing cutters.

Fishing Fleet, France.—Announcement is made that the French Government has appropriated the sum of 200,000,000 francs to be spent for the reorganization of the deep sea fishing industry of that country, the project including the construction of heavy oil-engined auxiliary craft and improvements of harbors and harbor facilities. One harbor, specifically is to be constructed at Lorient-Keroman, which is intended to be one of the largest and most efficient in the world. The vessels to be built for this fleet are to be, generally, of oil motor and sailing vessel type. No steam-driven crafts are included.

Enlarging Helsingfors Harbor, Finland.—According to plans of the Helsingfors City Council the present 3,000 meters (1 meter = 3.28 feet) of quays is to be lengthened to 27,000 meters, the cost being estimated at something like 100,000,000 Finnish marks. The project embraces a free harbor for South Busholmen. Helsingfors South Harbor will be used for Baltic shipping and passenger traffic. North Harbor will accommodate local traffic, while Sornas Harbor will be used for export, especially timber and lumber and their products. It is also planned that a part of Sveaborg will be incorporated as a part of Helsingfors Harbor.

Oil Fuel Installation, Aberdeen, Scotland.—The Ministry of Munitions is to erect a steel oil storage tank 70 feet in diameter, 30 feet deep, capacity 3,142 tons, with outlet pipes, to Mearns Quay, River Dee, and Albert Quay, Tidal Harbor. A concrete retaining wall, 524 feet long and 10 feet high, will surround the site.

Workman, Clark & Company Yards, Belfast.—A new agreement as to the future of Workman, Clark & Company's shipyards at Belfast has recently gone into effect. Sperling & Company, bankers, of London, now hold the majority interests in the firm on behalf of the Northumberland Shipbuilding Company, which now virtually owns the yard. Sir George Clark and Mr. C. E. Allan are managing directors of the shipbuilding and engineering departments, respectively, but Mr. Frank Workman and others of the directors have retired from the firm. A statement that the new owners of the company expect to extend the work is incorrect. It is understood that Sperling & Company, who control the Northumberland Shipbuilding Company, Ltd.; Doxford & Company, and the Workman-Clark concern, will also purchase the shipyard and works of Swan, Hunter & Wigham Richardson, Ltd., of Wallsend.

SHIPPING DEVELOPMENTS

New Steamship Service, Boston.—The New England Maritime Corporation intends to operate a steamship service between Boston, Los Angeles and San Francisco. There will be monthly sailings.

Freight Line, Philadelphia.—A new freight line between Philadelphia and Antwerp has been established by the Cunard Steamship Company, making the fourth route of Cunard steamers running from Philadelphia.

Baltimore Far East Service.—Baltimore business men express pleasure over the announcement that the Green Star Steamship Corporation will establish service between Baltimore and China and Japan ports.

Soliciting Freight Agent, Boston.—To meet the demands of increasing business the International Mercantile Marine Company has created at Boston the position of soliciting freight agent, and T. E. Carpenter has been appointed to fill it.

Towage Company, Bath, Me.—The Kennebek Towage Company has been formed, with Fred N. Boston, of Gardiner, president; Rupert H. Baxter, Bath, vice-president; Thomas S. Gibbons, Bath, treasurer and general manager; Walter S. Glidden, Bath, secretary.

Harriman Company Buys Line.—The Harriman Company, 120 Broadway, has acquired stock control of the Coastwise Transportation Company of Boston. It is understood this deal represents an investment of $6,500,000. The Coastwise Company is credited with owning nine ocean-going steamships.

Freight Service, Portland, Me.—Announcement has been made that the White Star-Dominion Line plans a regular freight service between Portland and the Mediterranean ports. The Lowrance Company also announces the beginning of the operation of a fleet between Portland and Hamburg, Germany, and between Providence and Manchester, England.

INTERNATIONAL

Marine Engineering

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Fig. 1.—View of North Yard of New York Shipbuilding Corporation from Aeroplane

The Largest Shipyard in the World

When Charles M. Schwab took charge of the operations of the Emergency Fleet Corporation early in 1918 one of the first policies that he adopted was the immediate expansion, wherever possible, of the old established shipyards throughout the country. As a result, up to the end of hostilities practically all of the tonnage for our overseas operations was produced in the established yards, with their rapidly expanded facilities. One of the most striking examples of this expansion in the older yards can be found at the plant of the New York Shipbuilding Corporation, Camden, N. J., now the largest shipyard in the world, which is described and illustrated in the following pages.

TO anyone who has not had occasion during the past two years to visit the yards of the New York Shipbuilding Corporation at Camden, N. J., a trip through the plant to-day would be a startling revelation. Not only has the plant grown, in point of size, until it can rightfully claim the distinction of being the largest self-contained shipyard in the world, but in the diversity of its products and the completeness of its equipment and organization it has set a high-water mark in modern shipbuilding activities.

If figures alone would tell the story of the remarkable growth of this industrial plant, it might be sufficient to point out that during the war the number of building ways had increased from 10 to 28, the number of fitting out piers from 2 to 9, the number of employees from 3,800 to 18,000, the value of vessels under construction from $33,-

Fig. 2.—View of New York Shipbuilding Corporation Plant from Aeroplane, South Yard in Foreground

000,000 ($10,000,000 merchant and $23,000,000 naval) to $150,000,000 ($60,000,000 merchant and $90,000,000 naval), or that the payroll of the company had increased ten-fold, totaling last year $27,394,656.69. But figures alone do not tell the story, and it is only by an examination of the details of the plant and its method of operation that a true conception of its significance can be gained.

Before attempting to describe, even briefly, the recent extensions to the plant, we wish first to call attention to the output of the yard and the nature of the work now on hand. In 1919 the yard launched 87,580 gross tons of shipping and delivered 86,727 tons. The corresponding figures for 1918 were 72,032 gross tons launched and 77,283 gross tons delivered. The tonnage delivered during the war (1915 to 1918, inclusive) was 240,000 gross tons. Up to the end of 1919 the yard had launched 228 vessels aggregating 772,518 gross tons and 1,272,500 horsepower. Up to the end of 1917 the yearly average had been 36,050 tons launched and 34,700 tons delivered.

Work on Hand

At the beginning of the present year the work on hand included two battleships, each of 32,600 tons displacement; one battle cruiser of 43,500 tons displacement; twenty-two destroyers, each of 1,200 tons displacement; nine twin-screw passenger and cargo steamships, each of 13,500 gross tons; six passenger and cargo steamships, each of 11,000 gross tons; two freight steamers, each of 12,000 tons deadweight; and one oil tanker of 12,750 tons deadweight. Since the first of the year other contracts have been added to this list.

It must be remembered that during the period covered by the above figures the yard was greatly handicapped in its production by the fact that enormous extensions to the plant were being made while the balance of the plant was turning out the finished product, a condition which made it impracticable for the plant to maintain its maximum production. Further difficulties had to be faced during the war in that the established yards were obliged to supply many of the officers and leading men for the new yards, thus decreasing their own efficiency in order that the shipbuilding talent in the country might be disposed to the best advantage. During this period, also, material for light destroyers and heavy freighters had to be handled through the shops at the same time and the shortage of skilled labor made it necessary to maintain a training school in the plant, all of which, of course, mitigated against the maximum efficiency of production.

Fig. 3.—View of Yorkship Village from Aeroplane

THE LARGEST SHIPYARD IN THE WORLD

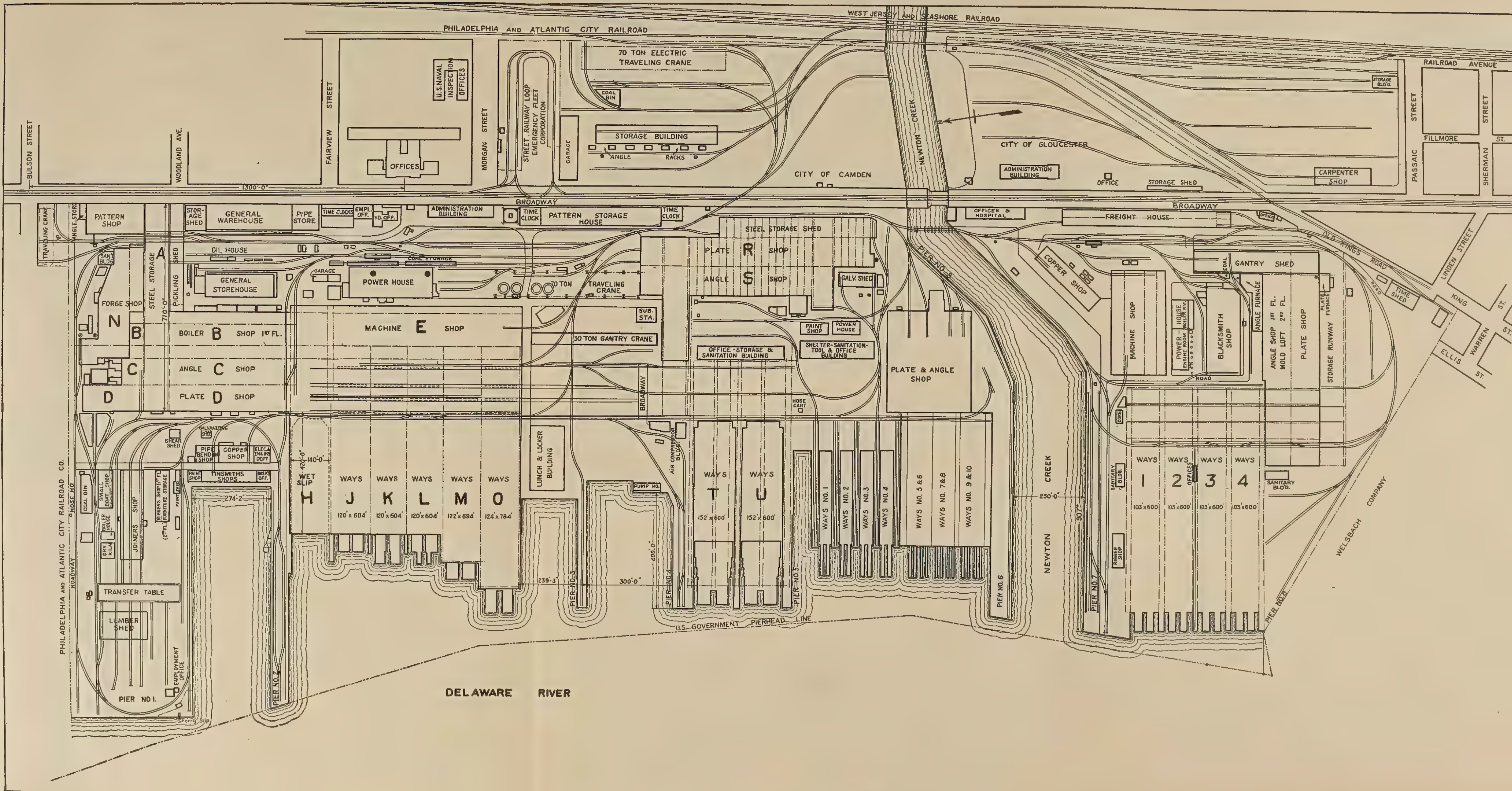


Fig. 4.—Map Showing the General Layout of the Shipyard of the New York Shipbuilding Corporation, Camden, N. J.

Fig. 5.—Typical Buildings at South Yard. (1) Carpenter Shop; (2) Administration Building; (3) Freight House; (4) Blacksmith Shop; (5) Copper and Machine Shops; (6) Gantry Shed; (7) Sanitary Shed; (8) Pump House, T and U Ways

Fig. 6.—"T" and "U" Ways from the River

In view of this it is safe to assume that, if these conditions had not prevailed, the output of the yard would have been materially greater.

The Original Yard

In order to get a comprehensive idea of the extent of the additions that were made to the plant during the war, it will be necessary to refer to the plan of the plant shown in Fig. 4. As originally laid out in 1899 and built in 1900, the New York Shipbuilding yard extended in a southerly direction only to and including ways *L*. The entire plant, comprising buildings *B, C, D, E,* wet basin *H* and ways *J. K* and *L,* was under one roof and, with the exception of ways *M* and *O* only minor additions to the plant, consisting chiefly of new equipment, were made from the time of its completion in 1903 until the recent extensive additions were begun during the war.

The original plant was designed in accordance with three general principles which at that time were considered unique and, by many of the shipbuilders, even impracticable. These principles were as follows: First, the application of the bridge shop practice of template-making to shipbuilding for the fabrication of practically all structural material going into the ships; second, the combining of the entire plant in a series of connected buildings, under one roof, for the manufacture of all essential parts of the ships, with a system of overlapping traveling cranes to reach all parts of the buildings without dependence on connecting railway tracks; third, fully enclosed ship sheds connected to and operated under the same conditions as the manufacturing buildings.

As shown by the plan (Fig. 4) this arrangement was carried out in the original plant, or the north yard as it is now called, with an assembling space at the head of the ways for fabricated ship material, beyond which is the machine shop with the steel storage, boiler, angle and plate shops at one side, the plate and angle shops being virtually extensions of the assembly space at the head of the ways. This same arrangement, it will be seen, has been carried out in its essential details, but with modifications and improvements in the new south yard at the south end of the plant in connection with ways 1, 2, 3 and 4. That the principles underlying the arrangement and method of operation of this plant were sound and practical has been amply proved by the work turned out in the twenty years' existence of the plant and by their adoption in one form or another by many other shipbuilders.

Beginning of the Expansion

When the yard was taken over by the New York Shipbuilding Corporation, a subsidiary of the American International Corporation, in December, 1916, the plant extended only to the south side of ways *O*. The entire southern end of the property owned by the company, or practically two-thirds of the entire property, was wholly undeveloped. The first addition to the yard consisted of two new sets of ways designated on the plan, Fig. 4, as ways *T* and *U*, the construction of which began in March, 1917. Plans for the construction of these ways included

Fig. 7.—Destroyer Yard

Fig. 8.—Destroyer Ways

Fig. 9.—Destroyers Being Fitted Out in Wet Dock

Fig. 10.—Ways, South Yard

Fig. 11.—Assembly and Storage Space at Head of Ways, South Yard

Fig. 12.—View of Ways, South Yard, from River

also the construction of a wet dock, 300 feet wide, on the north side of Pier 4. This dock was dredged by hydraulic dredges operated by the American Dredging Company of Philadelphia to a depth of 26 feet at low water and the material dredge out was pumped on to the site of ways *T* and *U*, filling out to the south side of Pier 5. Ways *T* and *U* are each 152 feet wide by 600 feet long, giving space for laying down four 500-foot vessels at a time. Plans for these ways contemplate their extension to twice their present length in order to accommodate vessels up to 1,000 feet in length.

T and *U* Ways

Ways *T* and *U* are of novel construction in that the ships built on these ways are erected directly on a sand foundation instead of the usual pile foundation. The ways themselves rest on concrete caps or sills, each 14 inches wide at the top, 24 inches wide at the bottom and 30 inches deep, spaced 5 feet apart. From the head of the ways down to the high-water mark, these sills are laid directly on the sand, but from there out the ways rest on wooden caps on wooden piles. In the old part of the plant, that is, ways *J*, *K*, *L* and *M*, the way foundations consist of wooden caps on wooden piles. The foundations for ways *O* consist of reinforced concrete caps on reinforced concrete piles. As a matter of fact, the new construction adopted for ways *T* and *U*, and used also in the development of the South yard, as will be mentioned later, cost only about one-third of the construction involving the use of pile foundations.

When the construction of *T* and *U* ways began the steel market was in such condition, due to the demands upon the steel mills from Europe, that it was impossible to get quick deliveries of steel for the superstructure for the ways, consequently a wooden superstructure was designed by E. H. Sapp, civil engineer of the plant, and erected by the McClintock-Marshall Company of New York, which has proved very successful. The first keel on these ways was laid in December, 1917. The first launching occurred on July 4, 1918, and at the end of 1919 ships had been launched from all four of these ways. The contract for pile driving and concrete work in the construction of these ways was handled by the Armstrong and Latta Company, Philadelphia.

While ways *T* and *U* were under construction, the lunch and locker building, south of ways *O*, was built. The construction of this was begun in November, 1917, the first floor of the building containing a locker room and the second floor a cafeteria capable of accommodating 700 men.

Complete Destroyer Yard Built

The next addition to the yard was the construction of a complete destroyer yard, the actual construction of

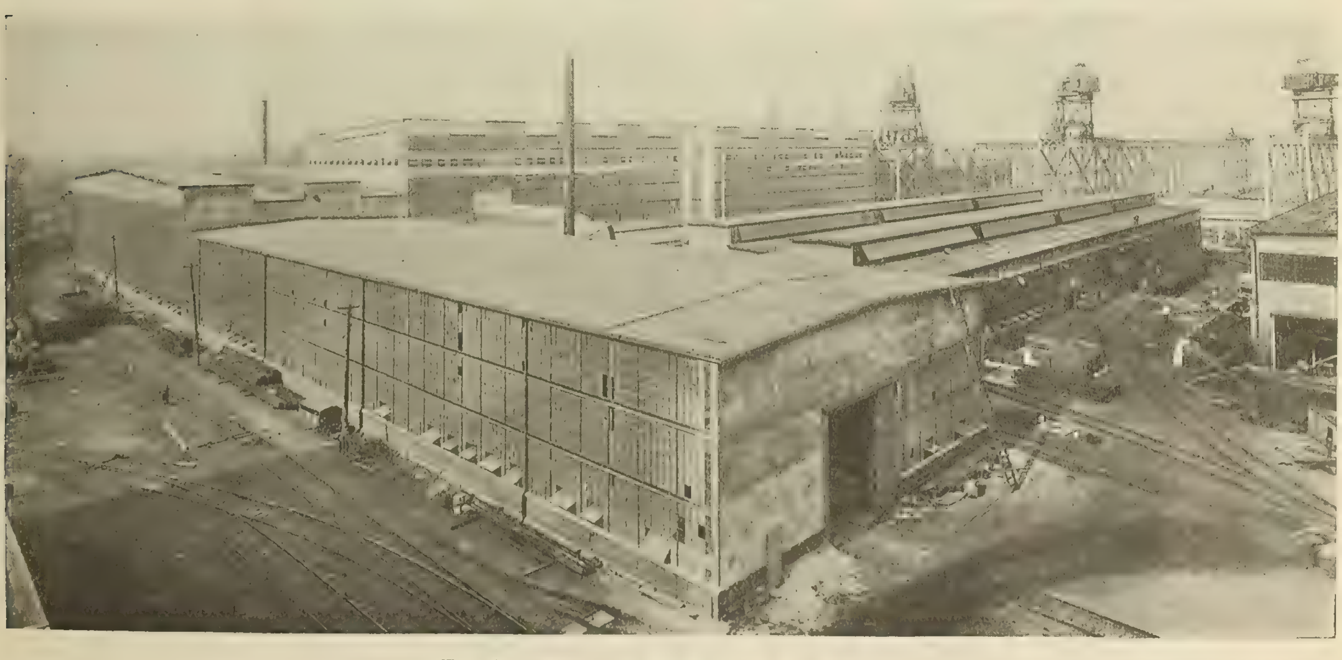


Fig. 13.—Plate and Angle Shop, South Yard

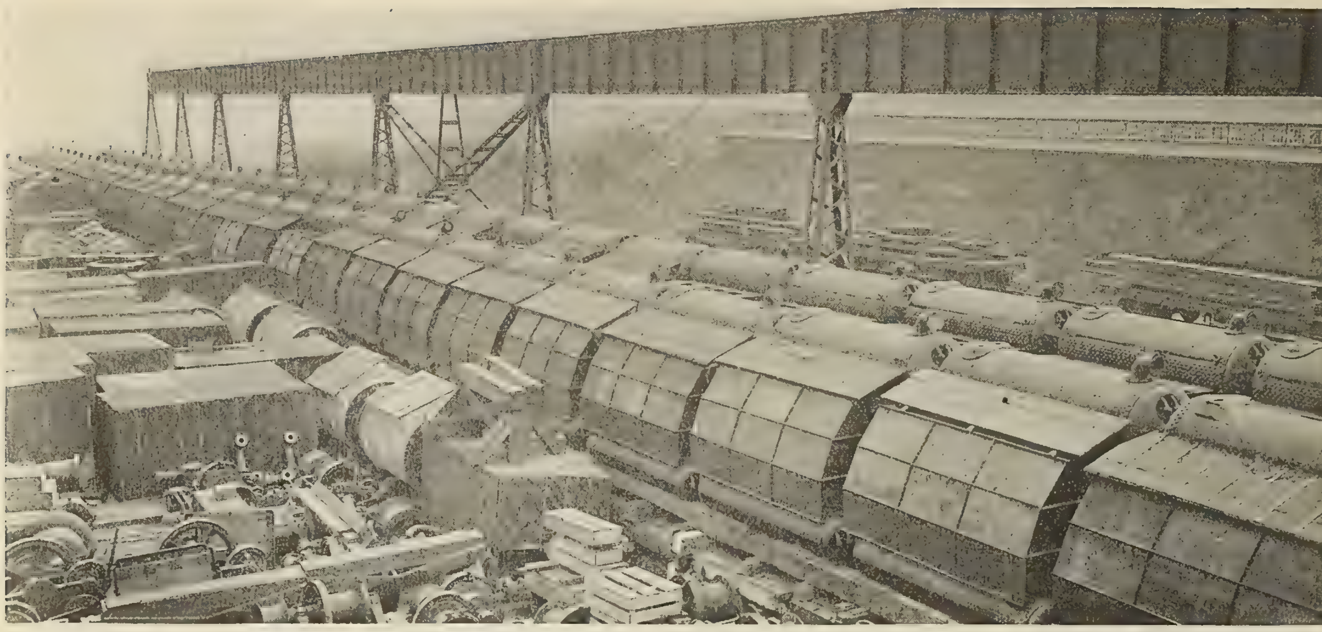


Fig. 14.—Watertube Boilers to Be Installed on Destroyers

which started on October 17, 1917. This project consisted of four open ways and six inclosed ways. The pile driving for foundation work was done by the Armstrong and Latta Company, Philadelphia. On the open ways material is handled by means of gantry whirler cranes supplied by the Dravo-Doyle Company, Pittsburgh. The covered ways are inclosed by a steel building in which are operated overhead traveling electric cranes. This building was erected by the American Bridge Company of New York on wood foundations consisting of piles capped with 12-inch by 12-inch square timber.

In addition to the ship ways, the destroyer plant included a plate and angle shop, 352 feet long by 282 feet wide; a power substation; a galvanizing plant, which,

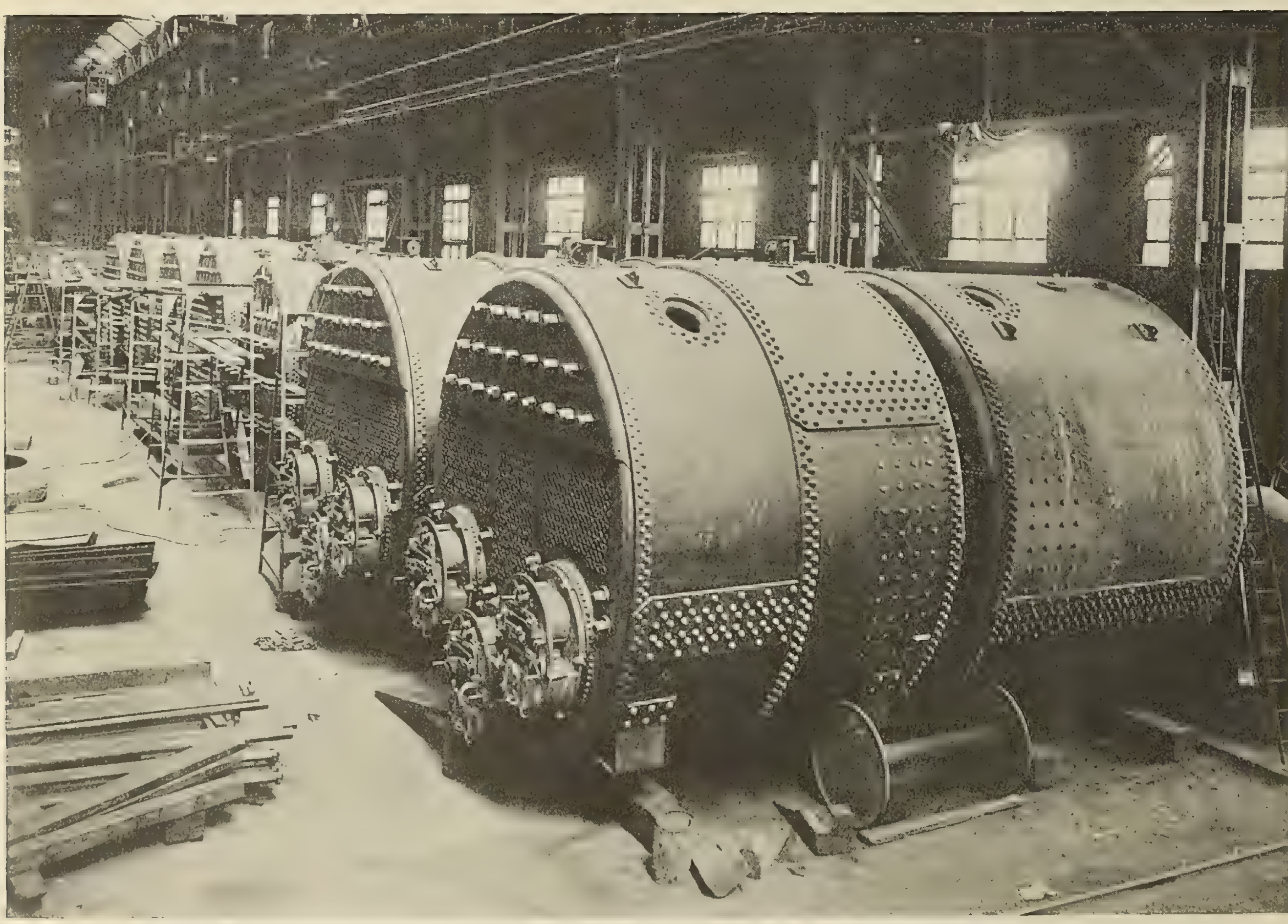


Fig. 15.—Scotch Boilers on Testing Floor, Boiler Shop, North Yard

Fig. 16.—General View of Boiler Shop, North Yard

Fig. 17.—Erection Floor, Boiler Shop, North Yard

Fig. 18.—Mold Loft Over R and S Plate and Angle Shop

Fig. 19.—Plate Storage, R and S Plate and Angle Shop

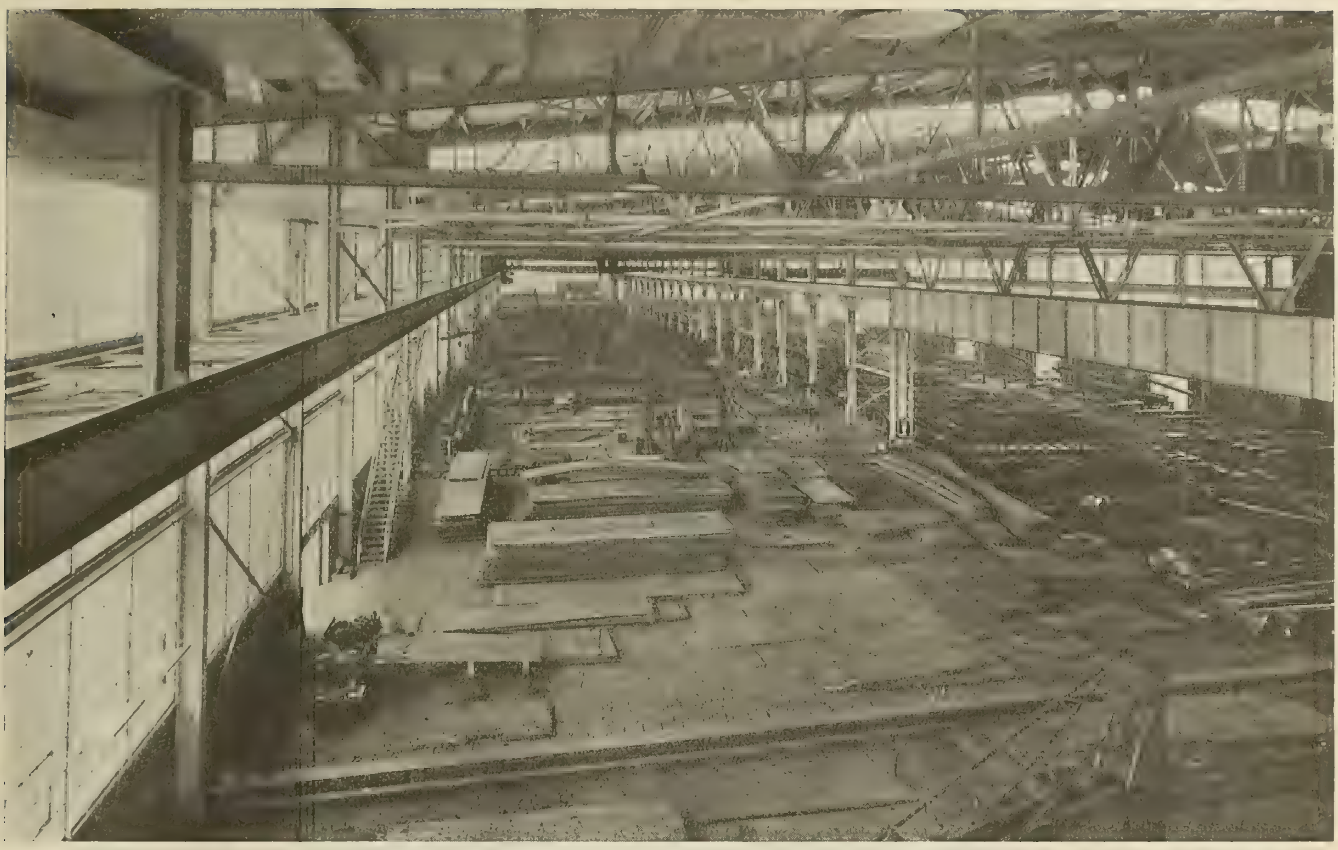


Fig. 20.—General View, Interior of R and S Plate and Angle Shop

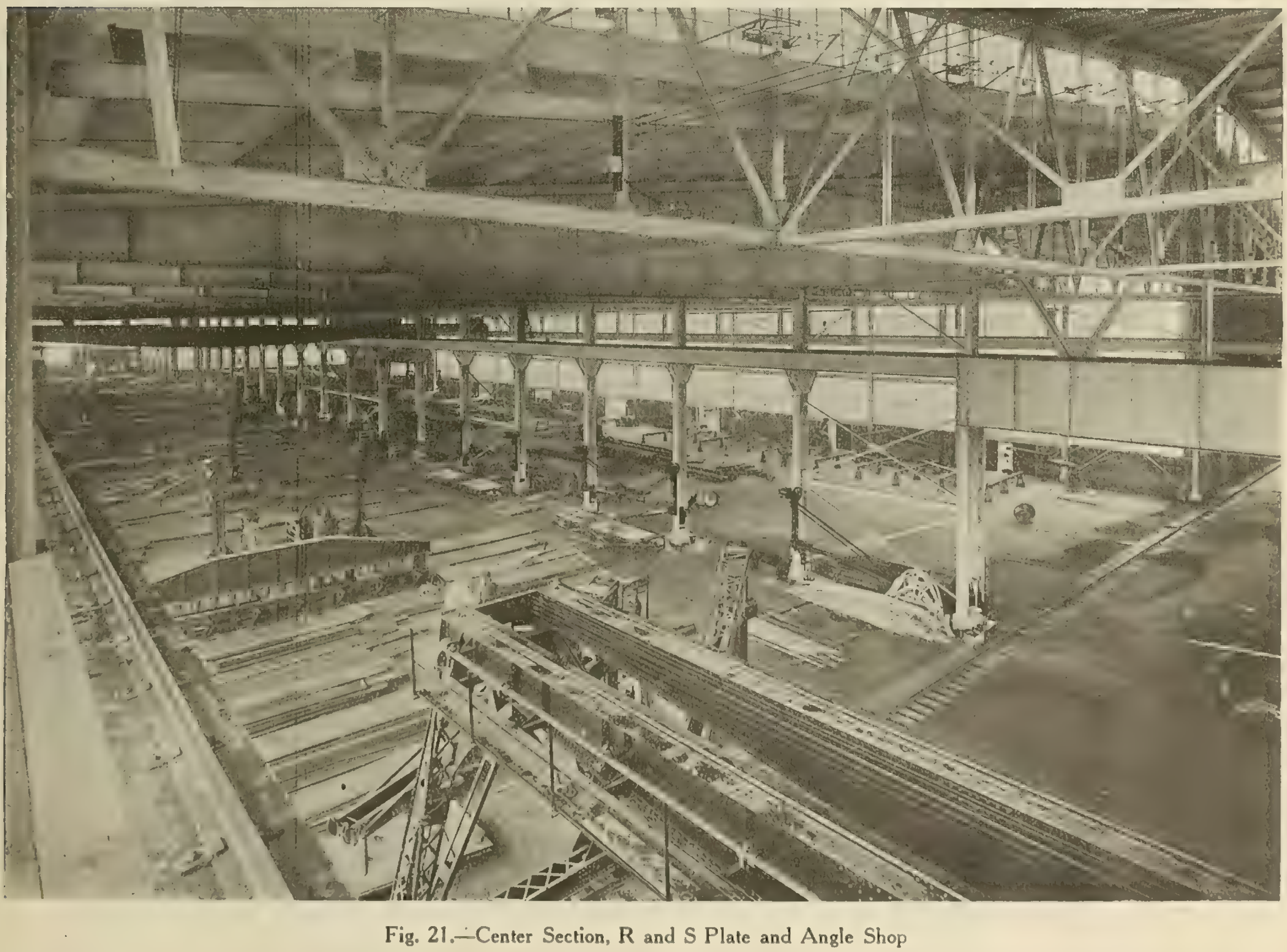


Fig. 21.—Center Section, R and S Plate and Angle Shop

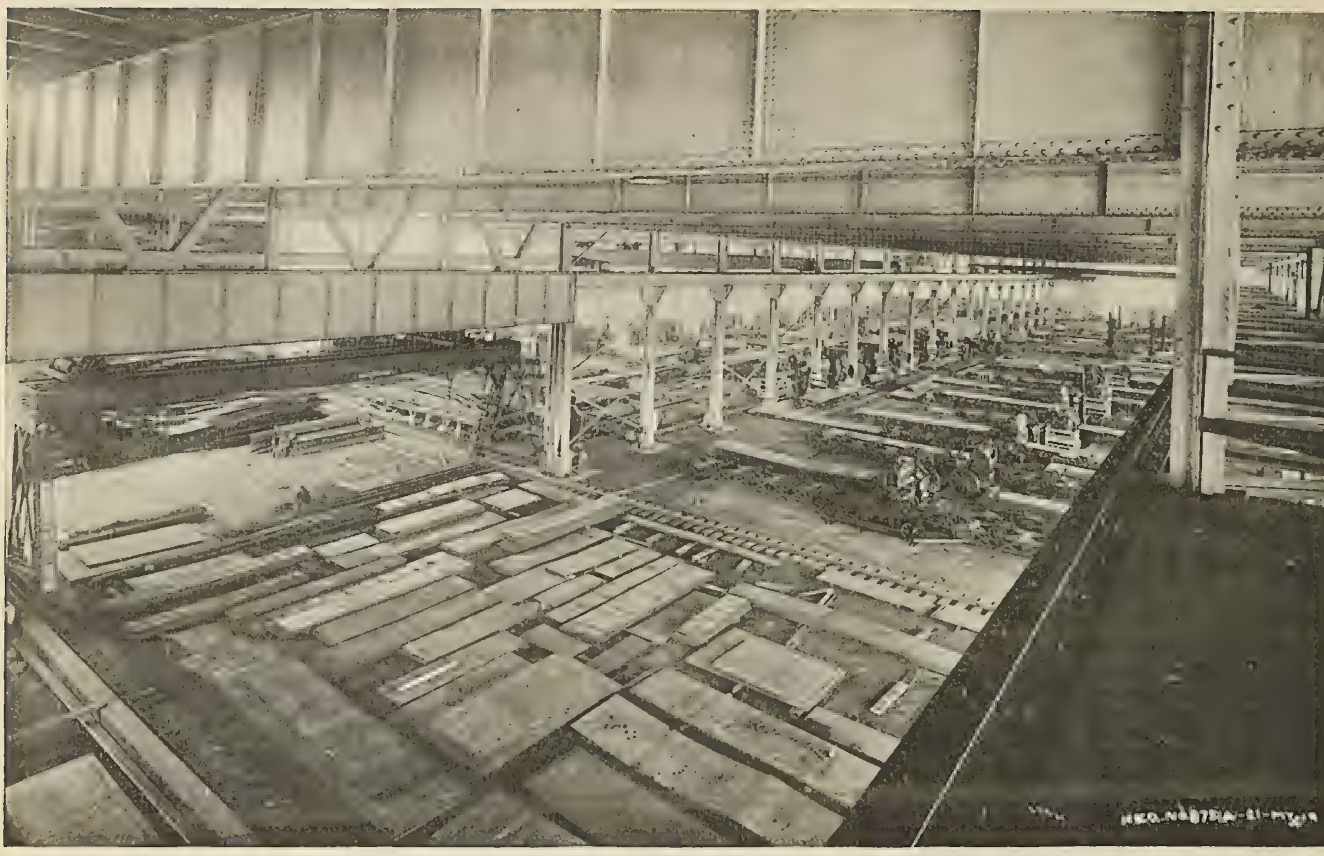


Fig. 22.—South End of R and S Plate and Angle Shop

Fig. 23.—Interior View of Machine Shop, South Yard, Before Completion

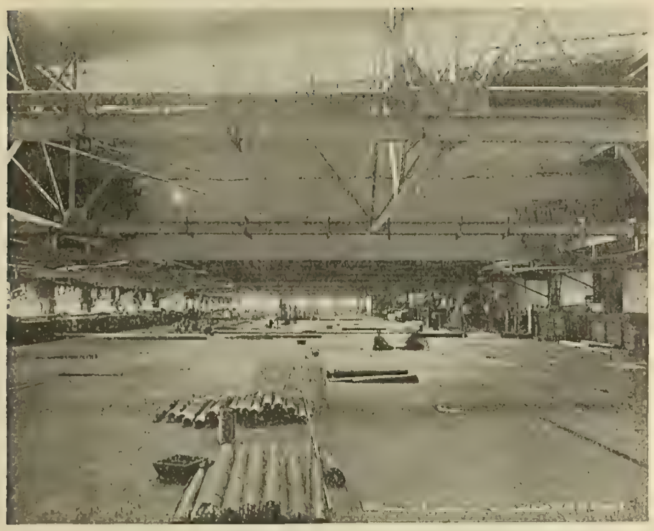


Fig. 24.—Mold Loft, North Yard

Fig. 25.—Interior Pipe Shop

incidentally, contains some of the largest galvanizing tanks in this country; a paint shop; a tool and office building and a storage house, 416 feet long by 64 feet wide, all built on land filled in by hydraulic dredging from Newton Creek at the south side of the yard. The dredging was carried out by the American Dredging Company. The plate and angle shop, tool and office building, power substation and storage house were built by the Holbrook, Cabot and Rollins Company, New York, of slow-burning timber construction. The galvanizing plant was built by J. S. Rogers, of Philadelphia, on foundations placed by Frazer, Brace and Company, New York, who also installed the concrete pits for the galvanizing tanks.

This project was built during the winter of 1917 and 1918, the most severe winter in the history of this location, and, on December 1, 1917, two of the open ways were ready for keels. The entire work was finished in April, 1918.

South Yard Extension

At this time the need of merchant ships became especially urgent and the Government adopted the policy suggested by Charles M. Schwab, at that time Director-General of the Emergency Fleet Corporation, of expanding where possible the old-established shipyards rather than attempting to build entirely new yards, the efficiency of which might be problematical. In line with this policy, the land owned by the New York Shipbuilding Corpora-

Fig. 26.—Plate and Angle Shop, South Yard

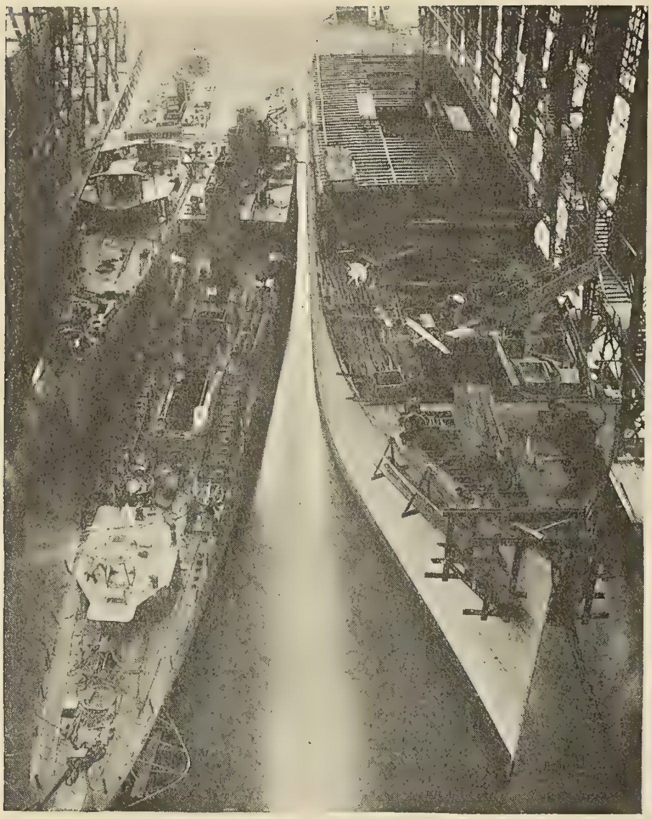


Fig. 27.—Wet Dock

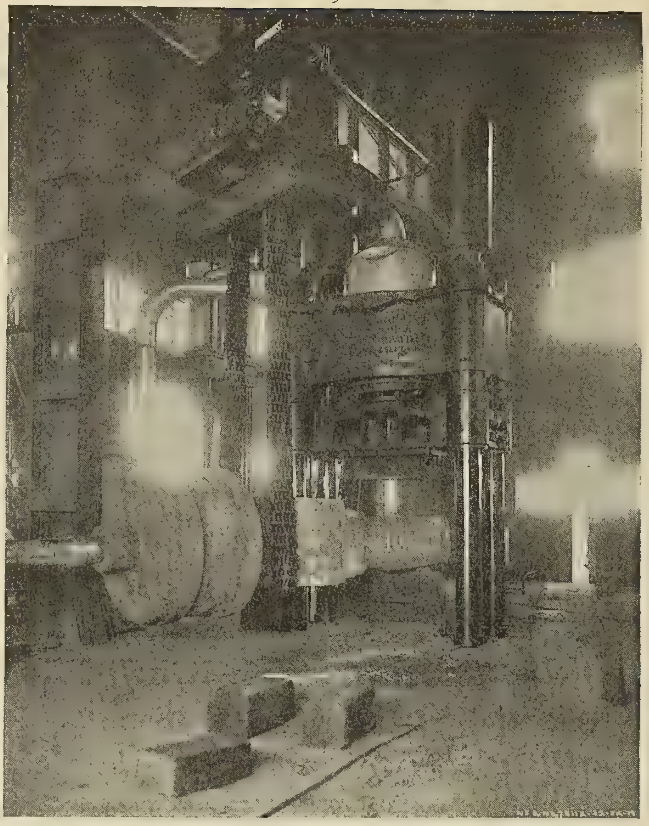


Fig. 29.—1,200-Ton Press in Forge Shop

tion, south of Newton Creek, was chosen as a site for the south yard extension. This south yard project included not only the building of the yard south of Newton Creek and west of Broadway, but also the development of all the land between Broadway on the west, the Atlantic City railroad and the Pennsylvania railroad on the east, Market street, Camden, on the north and Passaic street, Gloucester, on the south, all of which was below the elevation of high water.

Ideas for further expansion consummated in the planning of buildings *R* and *S*, which consist of a plate shop with a mold loft on the second floor, an angle shop and a steel storage building, all under one roof, being 792 feet long by 270 feet wide—probably the largest building in the country devoted to this character of work. The construction of buildings *R* and *S* started late in July, 1918, the piles for the foundation being driven by the Raymond Concrete Pile Company. Steel work on this building, amounting to approximately 3,500 tons, was fabricated by the L. F. Shoemaker Company, Pottstown, Pa., and erected by them on foundations prepared by Frazer, Brace and Company, New York. As shown by the illustrations, the walls of the building were practically of glass, the steel sash for which was manufactured and erected by the Truscon Steel Company. The stucco siding of the building was placed by Frazer, Brace and Company. The building was completed in March, 1919, and immediately put into operation. The equipment of the plant is very elaborate, the material being handled by overhead trav-

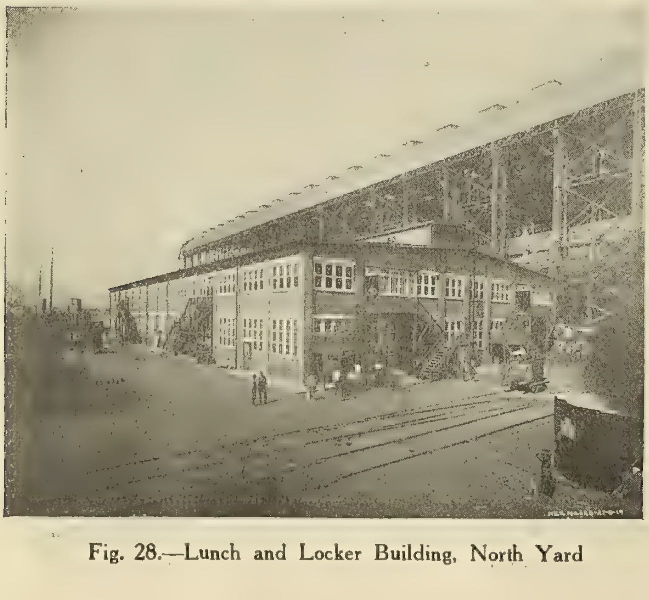


Fig. 28.—Lunch and Locker Building, North Yard

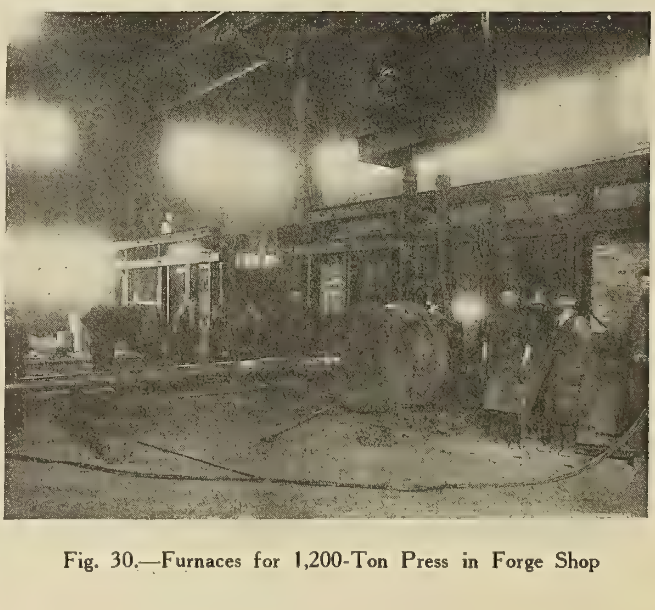


Fig. 30.—Furnaces for 1,200-Ton Press in Forge Shop

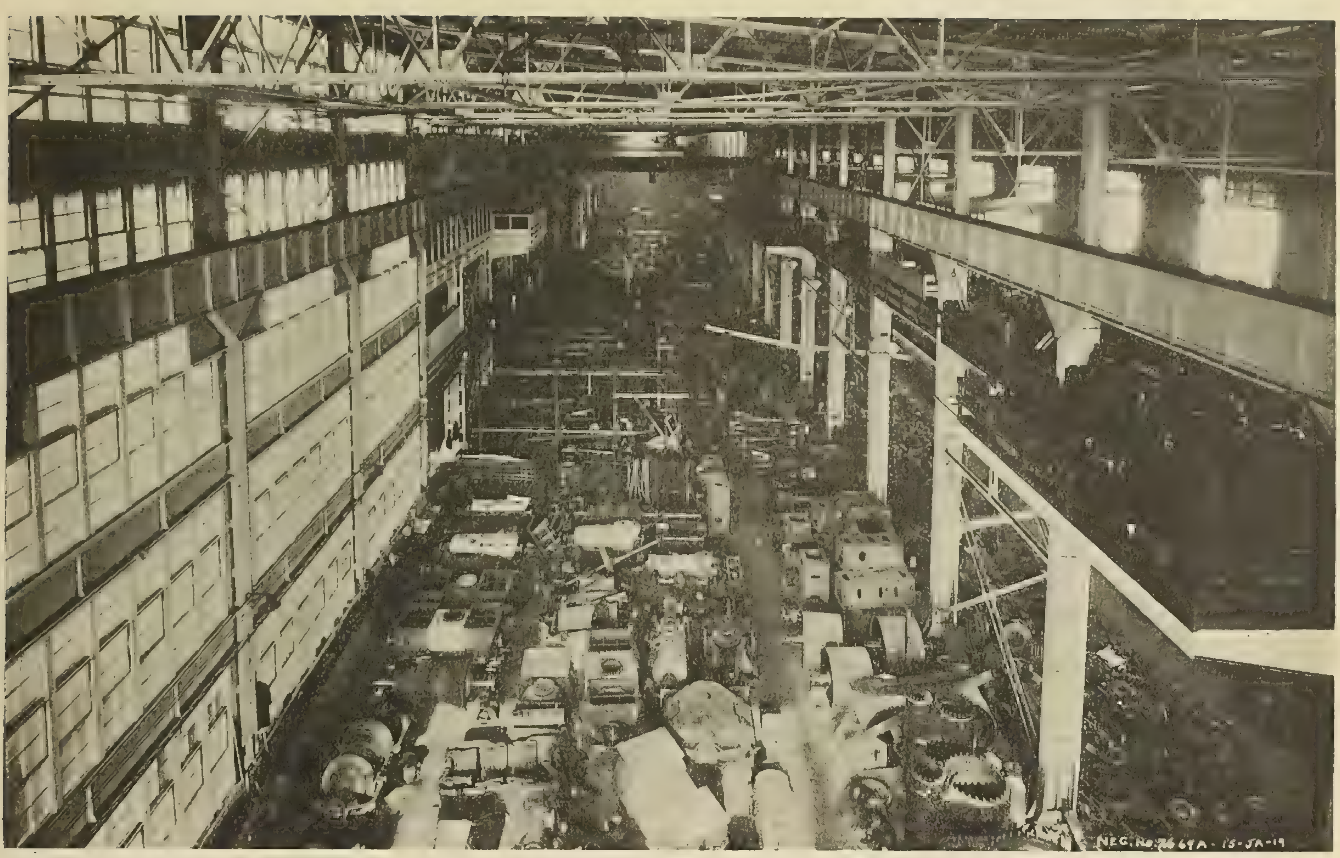


Fig. 31.—Extension of Machine Shop, North Yard

Fig. 32.—Main Floor of Machine Shop, North Yard

eling cranes and by heavy gantry cranes in the assembling sheds.

The South Yard

The South Yard was constructed originally for the Emergency Fleet Corporation, but since the end of the war has been taken over by the New York Shipbuilding Corporation and now forms an integral part of its plant. Construction of the South Yard began in June, 1918, a line of piles being driven on pier 7 by the Armstrong & Latta Company to form a sheet pile fence to retain the sand fill pumped from Newton Creek. Wooden piles were driven on piers 7 and 8 under the column foundations of the ship runways and in the water end of the shipways proper, extending from the mean high-water mark to the extreme outboard end of the underwater section of the ways. Over a total length of 1,600,000 linear feet 30,000 piles were driven.

Both wet and dry fill were used in preparing the site for the building of the yard. A portion of the dry fill came from a hill at the extreme south end of the yard, which was removed, supplying 100,000 cubic yards of material. The wet fill was placed by the American Dredging Company, of Philadelphia, which began operations on July 1, 1918, by filling in the low land north of Newton Creek. The land east of Broadway was developed principally as storage yards; the section between the Atlantic City railroad and Passaic street being used as steel storage for the South Yard, the section north of the Atlantic City railroad to Newton Creek as coal storage, and the section north of Newton Creek as steel storage for the North Yard. The latter storage yard is provided with a crane runway carrying an overhead electric crane of 80 tons capacity. The hydraulic fill placed in the entire South Yard project amounted to 540,000 cubic yards of material.

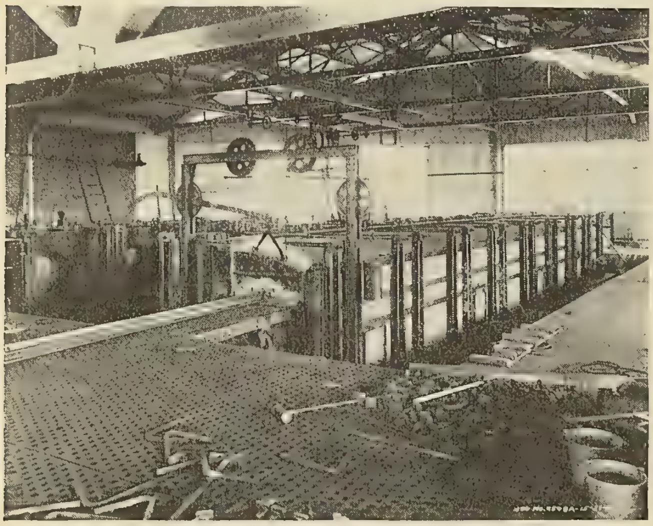


Fig. 33.—Furnaces in Plate and Angle Shop, South Yard

Fig. 34.—Angle Furnace, South Yard, Showing Underfeed Stokers

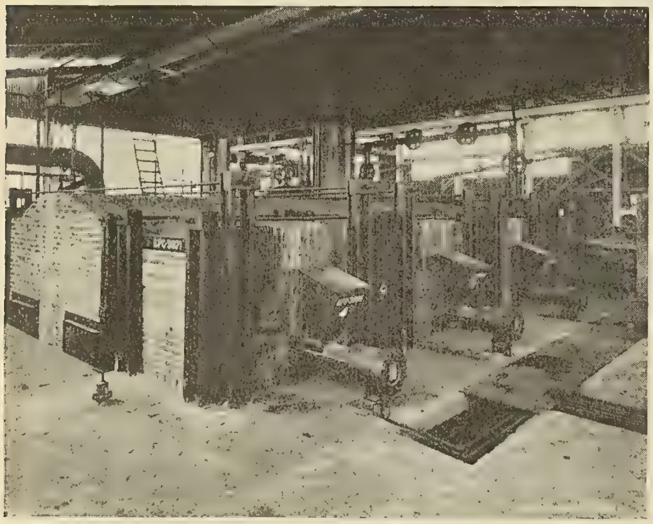


Fig. 35.—Coal-Fired Plate Furnace, South Yard

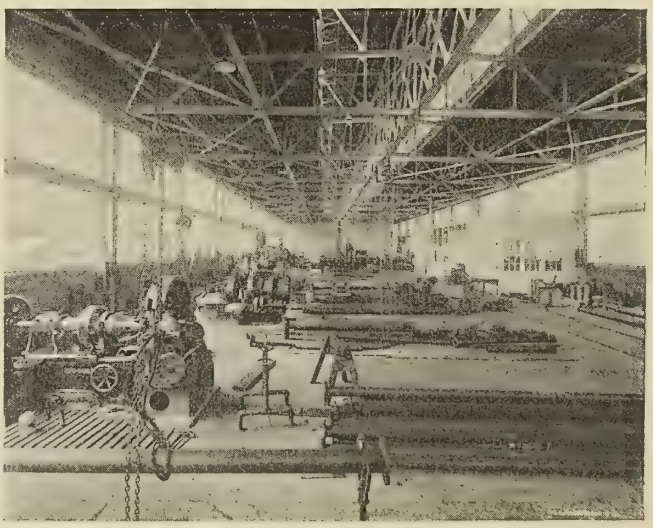


Fig. 36.—Copper Shop, South Yard

The layout of the South Yard is plainly shown on the plan, Fig. 4, the plant consisting of four sets of shipways each 103 feet wide and 600 feet long. At the head of the ways are three wide bays served by railway tracks and overhead cranes connecting with the plate and angle shops on the side and the machine shop, the blacksmith shop and other buildings in the rear. A feature of the construction of the building ways in the South Yard is the carrying out of the idea first used on ways *T* and *U*, as previously explained, of placing concrete sills in the hydraulic sand fill extending from the head of the ways down to the high-water mark. Although this is a radical departure from the methods of constructing shipways used in the original yard, nevertheless the concrete sills have been subjected to careful observation and have proved entirely satisfactory.

Fig. 37.—Views of Power Plant. (1) Power House, South Yard; (2) Power House, North Yard; (3) Interior of Main Power House, North Yard; (4) Boiler Room, North Yard, Showing New Equipment of Mechanical Stokers; (5) Boiler Room, North Yard, Before New Equipment Was Added

Fig. 38.—Views of Power Plant. (1) R and S Sub-Station; (2) T and U Sub-Station; (3) Interior of Pump House at T and U Ways; (4) Sub-Station; (5) Interior of Power House, South Yard; (6) Interior of Power House, Destroyer Ways; (7) Air Compressors in T and U Sub-Station

The superstructure on the ways at the South Yards is of steel, fabricated by the McClintic Marshall Company, Pittsburgh, Pa., and erected by them. At each runway there is a Brownhoist gantry whirler, tested for lifting a load of 45 tons at a 20-foot radius.

The first permanent building started in the South Yard was the plate and angle shop, the foundations for which were placed by the Hugh Nawn Contracting Company, Boston, Mass., in July, 1918. Shortly afterward the freight house foundations were started by the Raymond Concrete Pile Company, and then the blacksmith shop was started, the Raymond Concrete Pile Company driving the piles and the foundations being placed by the Hugh Nawn Contracting Company. The power house, copper shop and machine shop were started in the order named, and following these the administration building and carpenter shop were constructed on the east side of Broadway. In the entire project 5,300 concrete piles were driven. The shops in the South Yard are elaborately equipped with machine tools, overhead cranes, etc. Two 15-ton cranes serve the plate storage yard alongside the plate shop, six overhead cranes were installed in the plate and angle shop, and seven in the machine shop, one of 50 tons capacity, one of 20 tons, one of 15 tons and four of 10 tons capacity.

Fig. 39.—Small Boat Shop, South Yard

Fig. 40.—Freight House, South Yard

In the construction of the South Yard all concrete spread foot foundations and all foundations of Raymond concrete pile were placed by the Hugh Nawn Contracting Company and all foundations of wood piles were placed by the Armstrong & Latta Company. All steel for the buildings and runways, amounting to 10,000 tons, was fabricated and erected by the McClintic Marshall Company of Pittsburgh. The roof coverings of the buildings were placed by the Benjamin Foster Company, of Philadelphia. The steel sash was constructed and erected by the Truscon Steel Company, Youngstown, Ohio.

A feature of the building construction was the use of the cement gun in placing stucco siding on the buildings. In all, 12,000 square yards of stucco were placed by the Dewey Cement Company, of Allentown, Pa.

The yard was completed on August 31, 1919, long before which all of the shops were in operation, fabricating, and manufacturing ship material and ships were under construction on every set of shipways. The first keel in the South Yard was laid early in May, 1919. About 3,000 men are employed in the South Yard.

Fig. 41.—Brownhoist Crane on Ways, South Yard

Fig. 42.—Carpenter Shop, South Yard

Power Plant

Power for the entire shipyard is generated in two power plants, one in the North Yard and the other in the South

Fig. 43.—R. & S. Plate and Angle Furnaces

Fig. 44.—Lunch and Locker Building. Men Waiting to Be Served

Yard. Plans for enlarging and increasing the power plant were worked out by F. F. Kauffmann, mechanical engineer of the plant, to whom we are indebted for the following information:

In 1916 the main power plant in the North Yard was equipped with the following: Six Altman-Taylor water-tube boilers, rated at 266½ horsepower each and four Babcock and Wilcox boilers with the same rating, all built for 165 pounds working steam pressure and connected to a radial brick stack 11 feet inside diameter at the base, 8 feet 6 inches inside diameter at the top and 204 feet high. These boilers supply steam to two Ingersoll-Rand two-stage air compressors each with a capacity of 4,000 cubic feet of free air per minute at 100 pounds pressure; also one Ingersoll-Rand two-stage cross-compound air compressor of 3,200 cubic feet capacity at 100 pounds per square inch pressure.

The electrical generating units consisted of three 500 kilowatt direct-connected Westinghouse machines, two of which are of special design. One machine supplies both direct and alternating current at 240 volts. The third unit is a straight direct current machine of the same voltage. The above units are all piped up and arranged so that they can exhaust through a Bayer barometric condenser carrying 27 inches vacuum or they may exhaust to the heating system or to the atmosphere, as required.

In addition to the above-named units, there are two duplex tandem compound hydraulic pumps supplying a pressure of 1,500 pounds per square inch throughout the plant, each pump having a capacity of 150 gallons per minute. There are also three underwriters' fire pumps of 1,500 gallons per minute capacity each at 100 pounds per square inch pressure and the usual feed pumps, service pumps, feed water heaters, etc.

The boilers mentioned above were all hand fired, using a high-grade bituminous coal with settings of a standard type, providing a height of 6 feet from the floor to the under side of the tubes. These boilers were all equipped with draft gages, pyrometers for measuring the temperature of the stack gases, CO_2 recorders and gas collectors. Tests conducted on the old plant, operated day and night, showed a current cost over the switchboard of .43 cent per kilowatt based on the cost of fuel only, the cost per 1,000 pounds of steam evaporated from and at 212 degrees Fahrenheit, averaging about 16 cents. This was, of

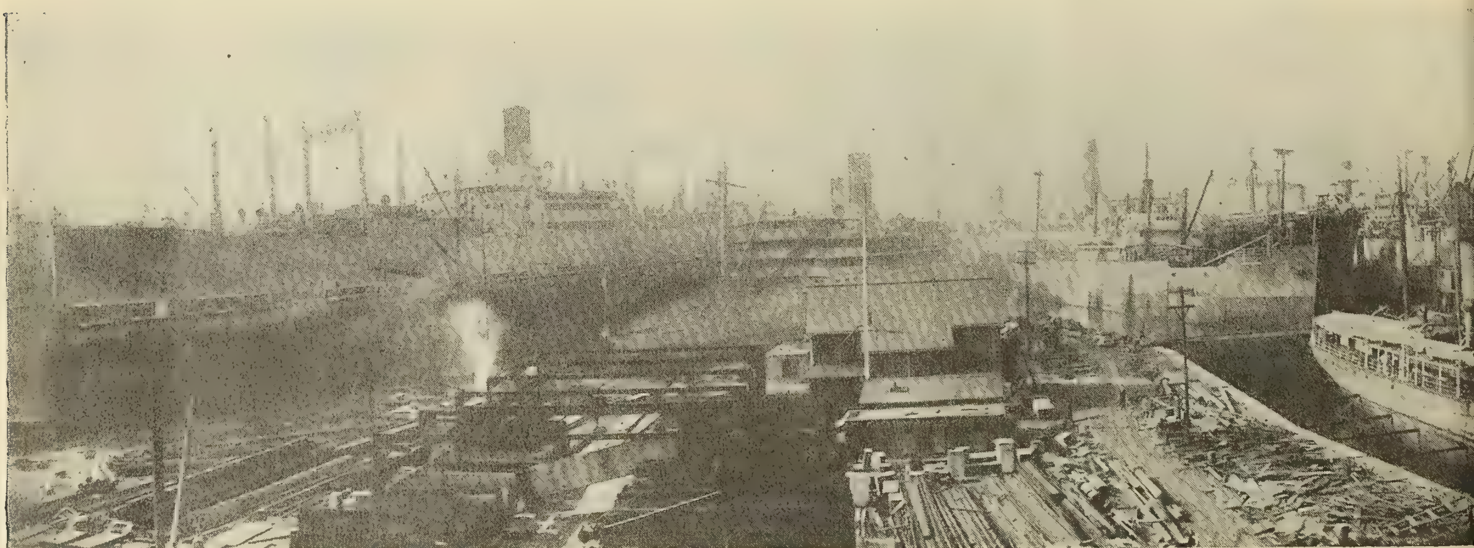


Fig. 1.—Section of Plant of Robins Dry Dock & Repair Company, Erie Basin, Brooklyn, N. Y. This is

course, based on the price of fuel prevailing at that time and showed remarkable economy for hand-fired units of this type.

At the beginning of the war the load began to increase materially, and it was decided to build an extension to the power house rather than buy the current from the Public Service Corporation. This decision was based on the fact that 30 percent of the total steam generated in the plant was required for electric power, while the other 70 percent was required for the air compressors, for heating the buildings, for testing, for water supply and for the requirements of the very large forge shop, which was added to the plant at this time.

The additions made to the power plant will be described in our next issue.

For the information and data given in this article we are indebted to the following officials of the New York Shipbuilding Corporation: H. A. Magoun, senior vice-president; E. H. Rigg, naval architect; E. H. Sapp, civil engineer; D. C. Nevins, assistant civil engineer; F. F. Kauffmann, mechanical engineer, and S. G. Jenks, general superintendent (South Yard).

The World's Largest Ship Repair Company

MORE than 225,000,000 tons of shipping, steam and sail, harbor, coastwise and deep water, have been dry docked in the big repair yards owned by the Todd Shipyards Corporation in New York harbor and on the Pacific coast.

This stupendous total is more than four times the merchant tonnage of the world at the end of 1919. These 225,000,000 tons, representing vessels of every size and type, have been handled by the nineteen floating docks and the two graving docks that are distributed among the various Todd yards. Excluded from this remarkable dry docking record are the thousands of vessels—from chunky but essential tugs to the speediest ocean greyhound —on which work has been performed at piers and elsewhere, in the harbor by the skilled mechanics of the Todd Shipyards Corporation.

There is no other ship repair organization in the world operating as many dry docks as this American company. The Todd dry docks placed end to end would measure nearly a mile and a half, and if the vessels that have been on those docks were set stern to bow they would span the continent from Erie Basin to Puget Sound.

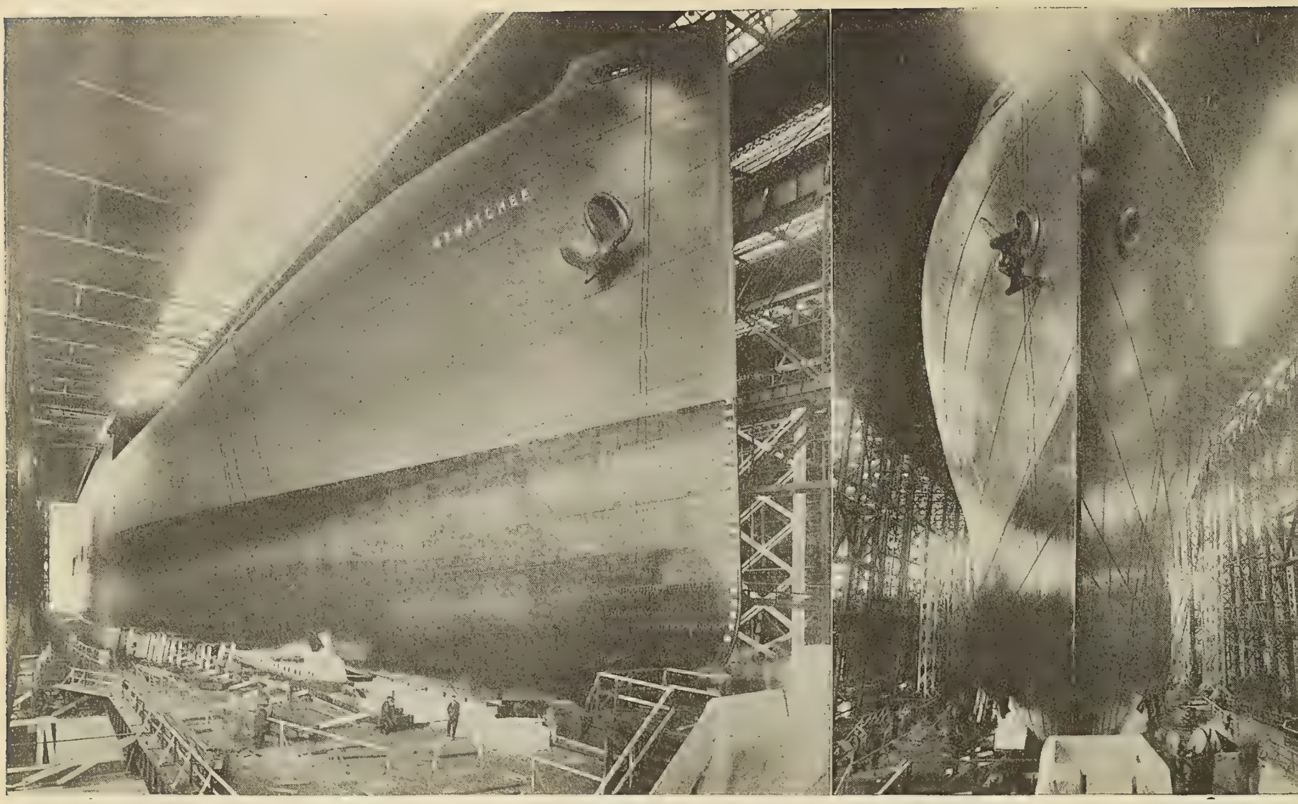
It seems appropriate at this time—the renaissance of American shipping—to cite the foregoing figures in the belief that they will convey some idea of the ship repair facilities of the world's largest ship repair organization. A ship is a ship only when in service, and if a nation would possess a merchant marine it must have adequate facilities for the proper upkeep of the ships that fly its flag.

The Todd organization is a federation of expert men and great plants for united application of the best modern industrial practice to every kind of shipwork from construction to interior decoration. It is equipped to build any vessel, from ocean liner to river barge. It possesses unsurpassed facilities for remodelling, lengthening and refitting ships of any character and for any service. It has made world records in the handling of the biggest repair jobs that ever have been sent to American yards. Its resources include nine construction ways, two graving docks, nineteen floating dry docks, twenty-five piers, a fleet of tugs, floating derricks and service craft and the latest improvements in shop equipment.

Co-operation binds all the organizations, yards and plants of the corporation into one powerful whole which is at any moment capable of concentrated effort. In all other respects, however, each organization is an independent unit for itself, with its individual prestige to maintain. This makes for exceedingly sharp competition between them all for achievement, efficiency, speed and economy; but there is free interchange of knowledge and experience, mutual enjoyment of inventions and improvments and, when necessary, exchange of resources.

Each plant is not only a unit in itself, but the unit principle is so applied that every vessel obtains unit treatment precisely as if it were the only vessel in a yard devoted entirely to it. This concentrated individual attention is made possible by ample berthing spaces and dockage capacities, an abundance of experienced workers, and every modern facility for applying power in all its forms directly to every ship.

One of the Subsidiaries of the Todd Shipyards Corporation, the World's Largest Ship Repair Organization



Figs. 1 and 2.—Views of 535-Foot Passenger Liner *Wenatchee* Ready for Launching at North Yard of New York Shipbuilding Corporation, Camden, N. J.

New American Passenger Steamers

Description of 17½-Knot, 535-Foot Passenger and Cargo Vessels Building for the Shipping Board—Gross Tonnage, 13,500

ONE of the most striking features of the huge shipbuilding program started by the United States Shipping Board during the war, and now nearing completion, is the fleet of large passenger and cargo steamships which were first laid down as troop ships, but which are now being fitted out for fast passenger and mail service. This fleet is composed of two types of vessels. In the first the vessels are 535 feet long of 13,500 gross tons and 17½ knots speed, and in the second 502 feet long between perpendiculars, of 10,500 gross tons and 14 knots speed.

Of the larger vessels, nineteen are now under construction, distributed among the yards of the New York Shipbuilding Corporation, Camden, N. J., the Sparrows Point (Md.) plant of the Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa., and the Newport News Shipbuilding and Dry Dock Company, Newport News, Va. According to the tentative plans of the Shipping Board for the development of passenger service from American ports, twelve of these vessels will be assigned to the following routes on the Pacific:

Weekly sailings to Japan, China and the Philippines.

Weekly sailings to Japan, China and Vladivostock.

Sailings every three weeks to the Philippines, the Straits and India.

Four of these vessels will be required for each of these services and the remaining vessels of the fleet will be operated on the Atlantic. As the building of these ships marks the beginning of a new era in American shipping, by the establishment of regular overseas passenger lines, the details of construction and equipment of the vessels are of more than passing interest.

In the first place the new American liners will embody the latest ideas in the development of hull and machinery construction, combining the characteristics of safety and speed and comfort and convenience, which make the modern liner the mistress of the seas. They are twin screw, turbine-driven vessels of 13,500 gross tons, with a deadweight carrying capacity of 11,000 tons, fitted with oil-burning watertube boilers, and are capable of maintaining a sea speed of 17½ knots with a steaming radius of 11,700 miles. The main particulars of these vessels are as follows:

Length overall	535 feet
Length between perpendiculars	534 feet
Beam, molded	72 feet
Depth to "*A*" deck, molded	50 feet
Draft, summer	30 feet 6 inches
Gross tonnage, about	13,500
Deadweight tonnage, about	11,000
Service speed	17½ knots
Steaming radius	11,700 miles
Shaft horsepower	12,000
Fuel oil capacity	3,267 tons
Boiler feed water	213 tons
Potable water	651 tons
Bale capacity	455,536 cubic feet
Ship's cold storage	9,900 cubic feet
Cargo cold storage	3,950 cubic feet
Number of first class passengers	253
Number of maids	4
Number of second class passengers	300
Number of crew	182

The first-class accommodations will compare favorably with those of the finest ships afloat. The designs of the furniture, draperies, decorations, etc., are being prepared by W. and J. Sloane & Company, New York. As shown by


Bulkhead No. 32

NEW AMERICAN PASSENGER STEAMERS

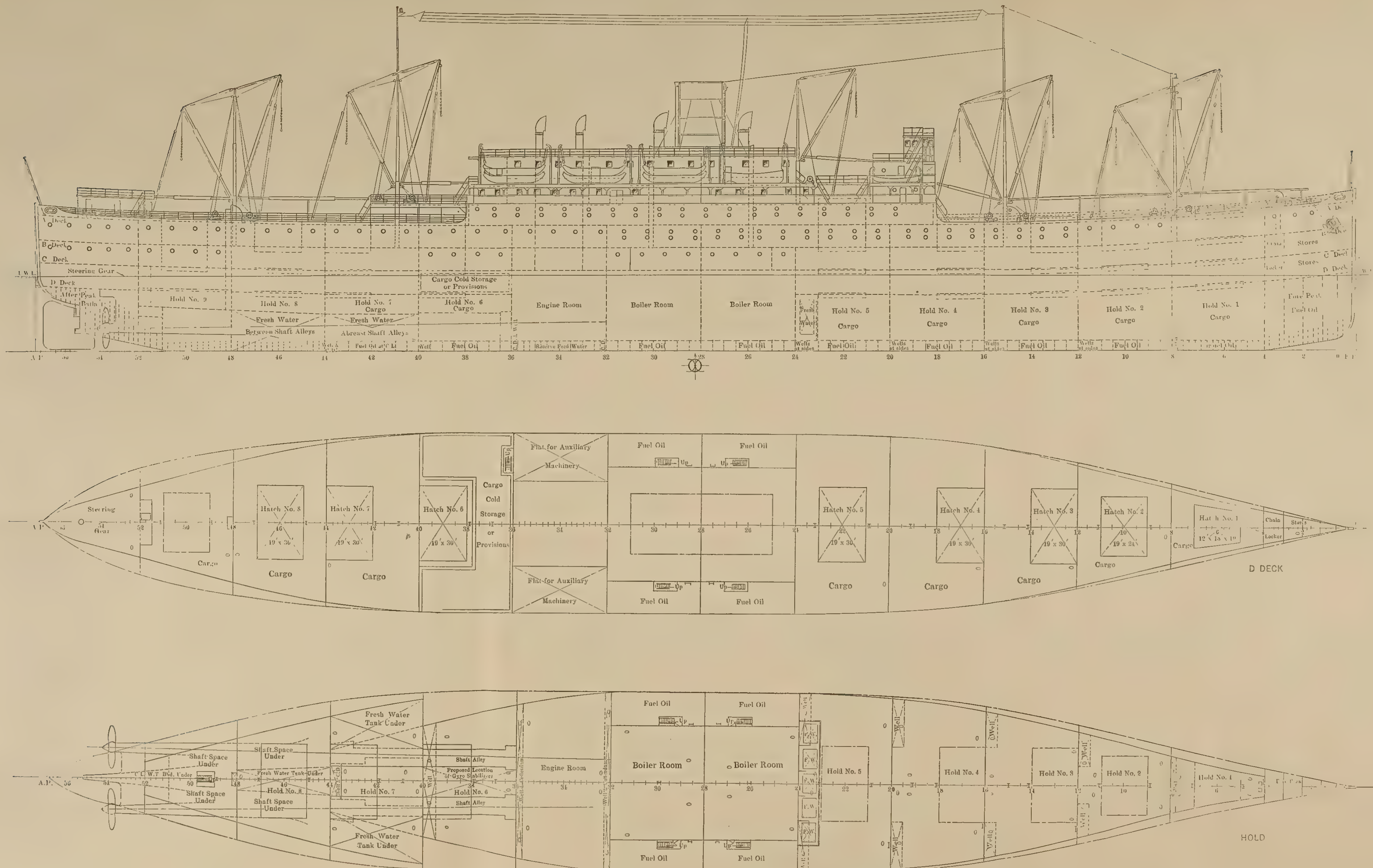


Fig. 3.—Profile and Lower Deck Plans of 535-Foot, 17½-Knot Ship

NEW AMERICAN PASSENGER STEAMERS

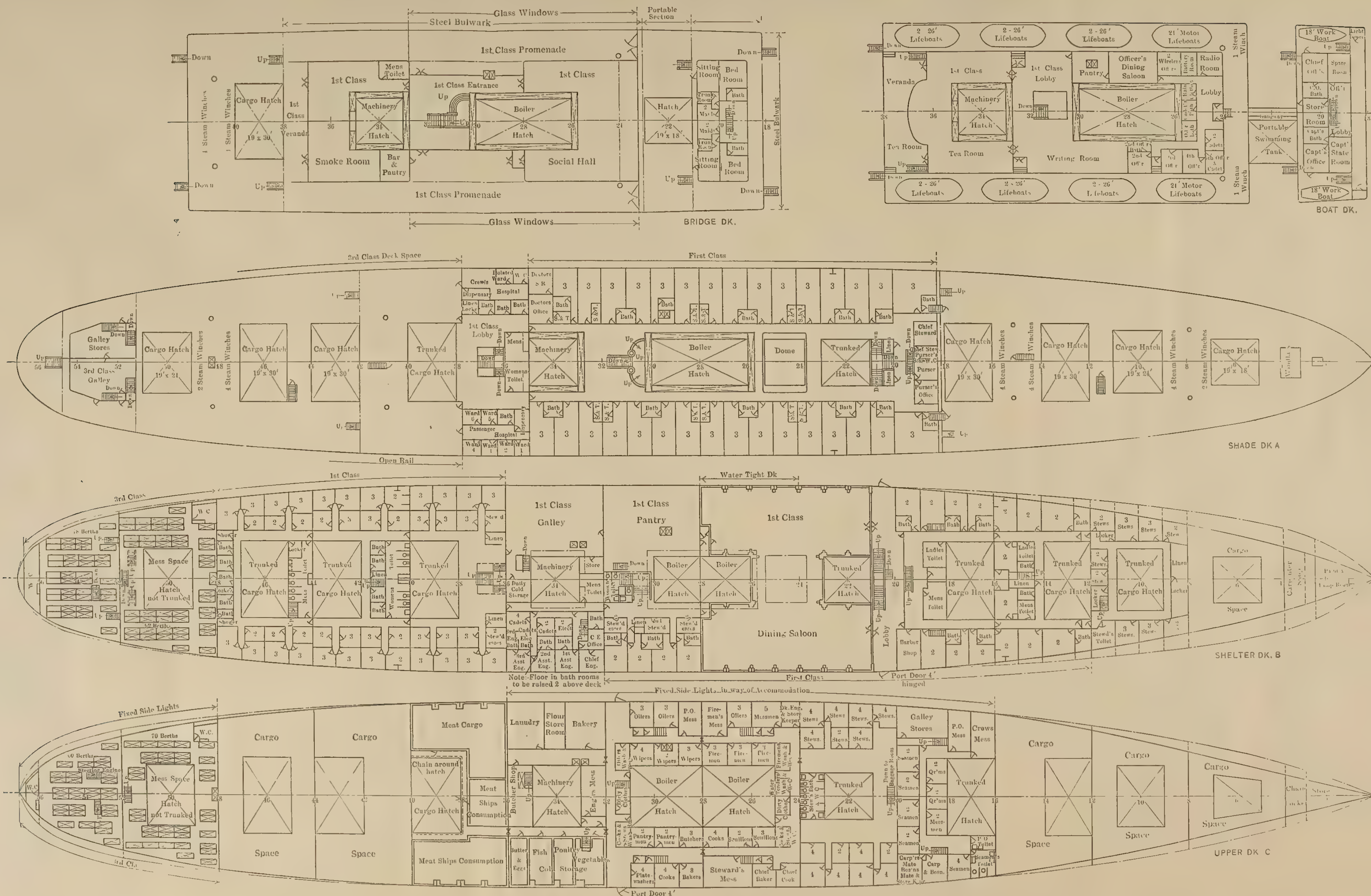


Fig. 4.—Deck Plans of 535-Foot, 17½-Knot Ship

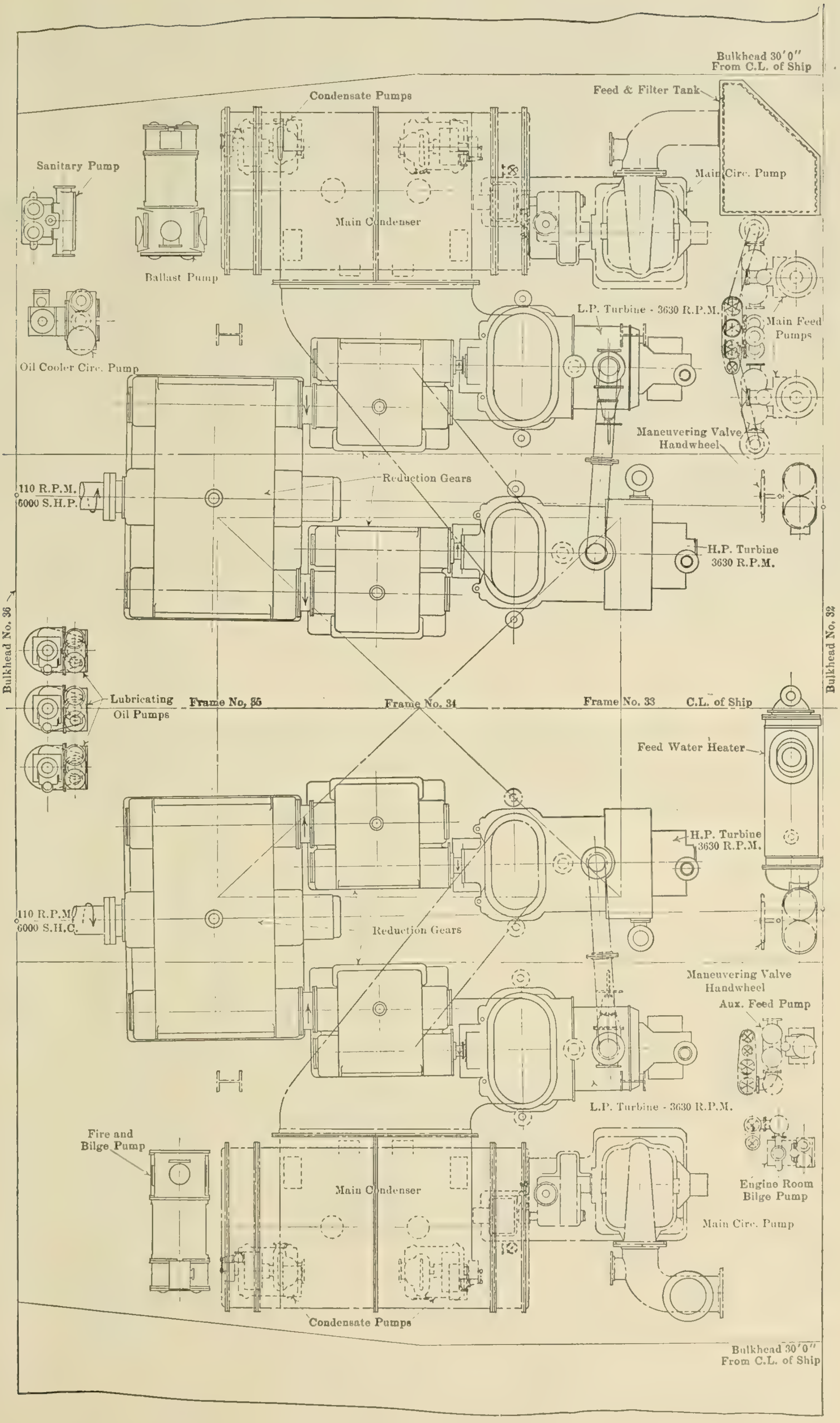


Fig. 5.—Plan of Engine Room

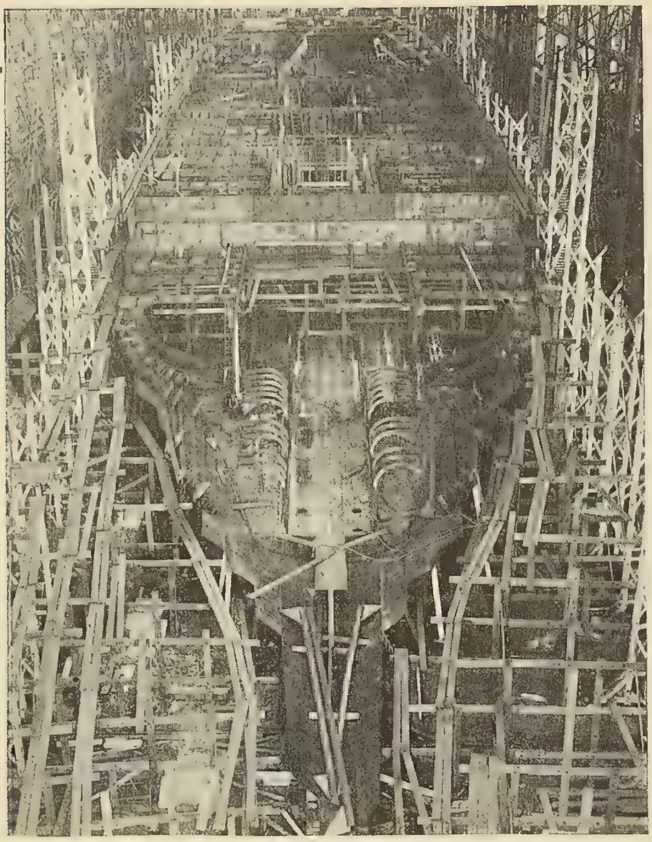


Fig. 6.—Stern View, S. S. *Wenatchee*

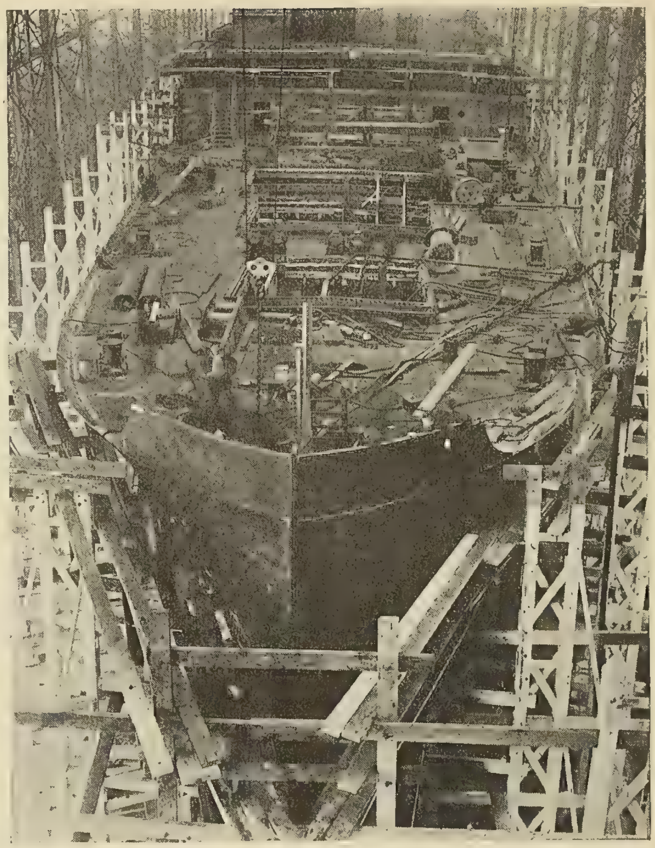


Fig. 7.—Bow View, S. S. *Wenatchee*

the general plans of the vessels, reproduced in this issue, the arrangement of the public rooms, staterooms and private suites provides every convenience and luxury that can be found ashore. In all, there are five decks given over to passenger accommodations, designated as the boat deck, bridge deck, shade deck (*A*), shelter deck (*B*) and upper deck (*C*).

The forward part of the boat deck is given over to the working of the ship and quarters for the navigating officers. Aft on the boat deck is a large first-class lobby, writing room and tea room. At the after end of the tea room is an open veranda.

On either side of the bridge deck is a wide promenade, closed in for the most part by glass windows. Within the deck house are the first class entrance, social hall and smoking room. Forward are two private suites, each consisting of a sitting room, bedroom and bath, and accommodations for four maids.

Below, on the *A* or shade deck, the space amidships is given over to first class staterooms with private baths. Aft of these accommodations on the starboard side is a hospital for passengers and on the port side a hospital for the crew.

The first-class dining room extends clear across the vessel amidships on the *B* or shelter deck. Forward of the dining room are first-class accommodations, and aft on the port side the first-class pantry and galley, while

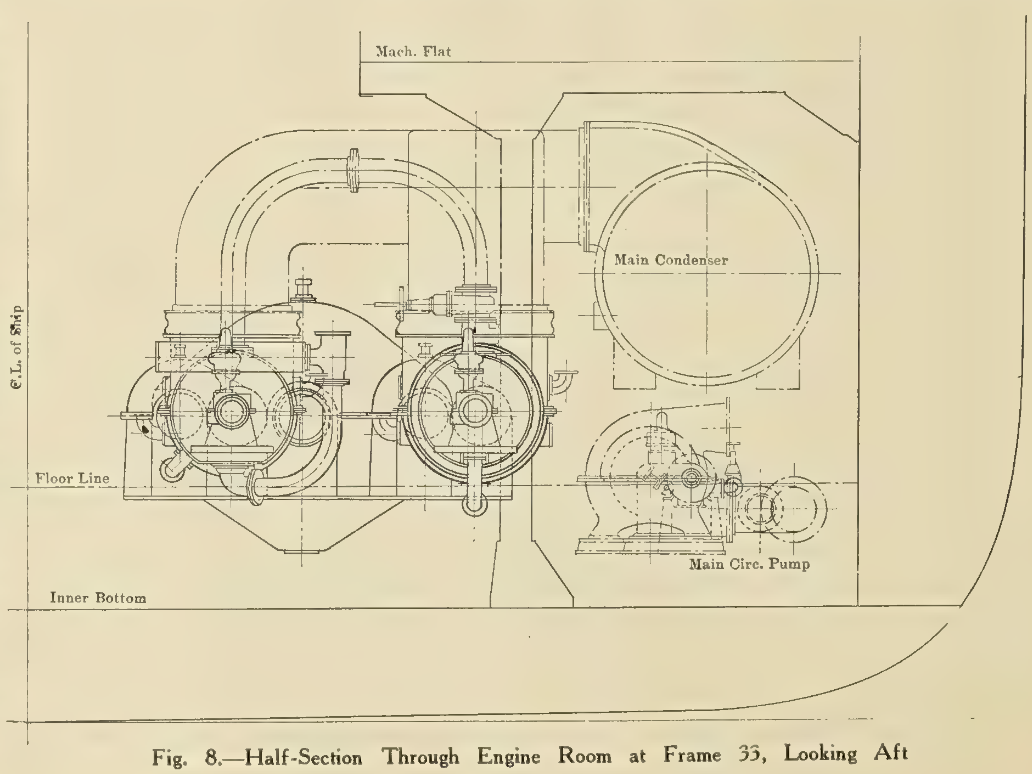


Fig. 8.—Half-Section Through Engine Room at Frame 33, Looking Aft

on the starboard side abreast the machinery casings are quarters for the engineers and stewards. Aft of the engine room hatch are additional first-class accommodations, while clear aft, on both this and the deck below, are the berthing and mess spaces for the second-class passengers.

Aside from the cargo spaces forward and aft on the *C* or upper deck, the space amidships is taken up by the quarters and mess rooms for the crew, aft of which are the ship's cold storage rooms, laundry, bakery, etc. Clear aft on this deck, as stated above, are part of the accommodations for second-class passengers.

The lifesaving equipment of the vessel includes fourteen 26-foot lifeboats, two 24-foot motor lifeboats and two 18-foot work boats, all stowed on the boat deck under mechanically operated davits.

Hull Construction

The vessels are being classed by both the American Bureau of Shipping and Lloyds. The hull is built on the Isherwood system of longitudinal framing with a double bottom extending throughout the length of the vessel. Thirteen transverse bulkheads, all of which, with the exception of one in way of the first-class dining room, extend up to the shade deck, divide the hull into fourteen watertight compartments.

For three-fifths length amidships, there is an outer keel 52 inches by .92 inch, and an inner keel 38½ inches by .74 inch, while at the ends the keel is reduced to a single plate .84 inch thick. The center girder is 50 inches deep and .64 inch thick amidships reduced to .50 inch at the ends and increased to .68 inch in the boiler space. The center girder is joined to the keel by double continuous angles 6 inches by 6 inches by .56 inch reduced to .50 inch at the ends, and to the tank top by double continuous angles 3½ inches by 3½ inches by .58 inch reduced to .54 inch at the ends, and increased to .68 inch in the boiler space. On each side of the center girder there are three side girders of .46 inch plate amidships reduced to .40 inch at the ends and increased to .46 inch in the boiler space.

The bottom plating is .74 inch to .52 inch, and the side plating .70 inch for one-half length reduced to .48 inch at the ends. The sheer strake at the shade, or *A*, deck is .88 inch for one-half length reduced to .48 inch at the ends. The tank top plating is .48 inch to .42 inch thick, increased to .58 inch in the engine room and to .62 inch in the boiler space. The margin plate, which extends straight out to the side of the vessel, is .56 inch, increased to .60 inch in the boiler space. The deck plating and stringers are as follows:

Deck	*Plating*	*Stringer*
(*A*) Shade	.50 inch to .38 inch	.74 inch to .46 inch
(*B*) Shelter	.44 inch to .32 inch	.48 inch to .46 inch
(*C*) Upper	.36 inch to .32 inch	.42 inch
(*D*) Main	.34 inch to .30 inch	.40 inch

Longitudinals and Transverses

The longitudinals are all of channel sections of the following sizes:

Nos. 1 and 2: 6 inches by .35 inches by 3.5 inches by 15 pounds.

Nos. 3 and 4: 7 inches by .313 inch by 3.313 inches by 15.6 pounds.

Nos. 5 and 6: 7 inches by .438 inch by 3.438 inches by 18.6 pounds.

Nos. 7, 8 and 9: 10 inches by .375 inch by 3.375 inches by 21.8 pounds.

Nos. 10 and 11: 10 inches by .475 inch by 3.47 inches by 26.4 pounds.

No. 12: 10 inches by .50 inch by 3.5 inches by 27.2 pounds.

No. 13: 10 inches by .55 inch by 3.55 inches by 28.9 pounds.

Bottom: 7 inches by 3.438 inches by 3.438 inches by 18.6 pounds.

Shade, shelter and upper decks: 6 inches by 3.5 inches by 3.5 inches by 15 pounds.

Main deck: 7 inches by 3.313 inches by 3.313 inches by 15.6 pounds.

Tank top: 7 inches by .35 inch by 3.35 inches by 16.5 pounds.

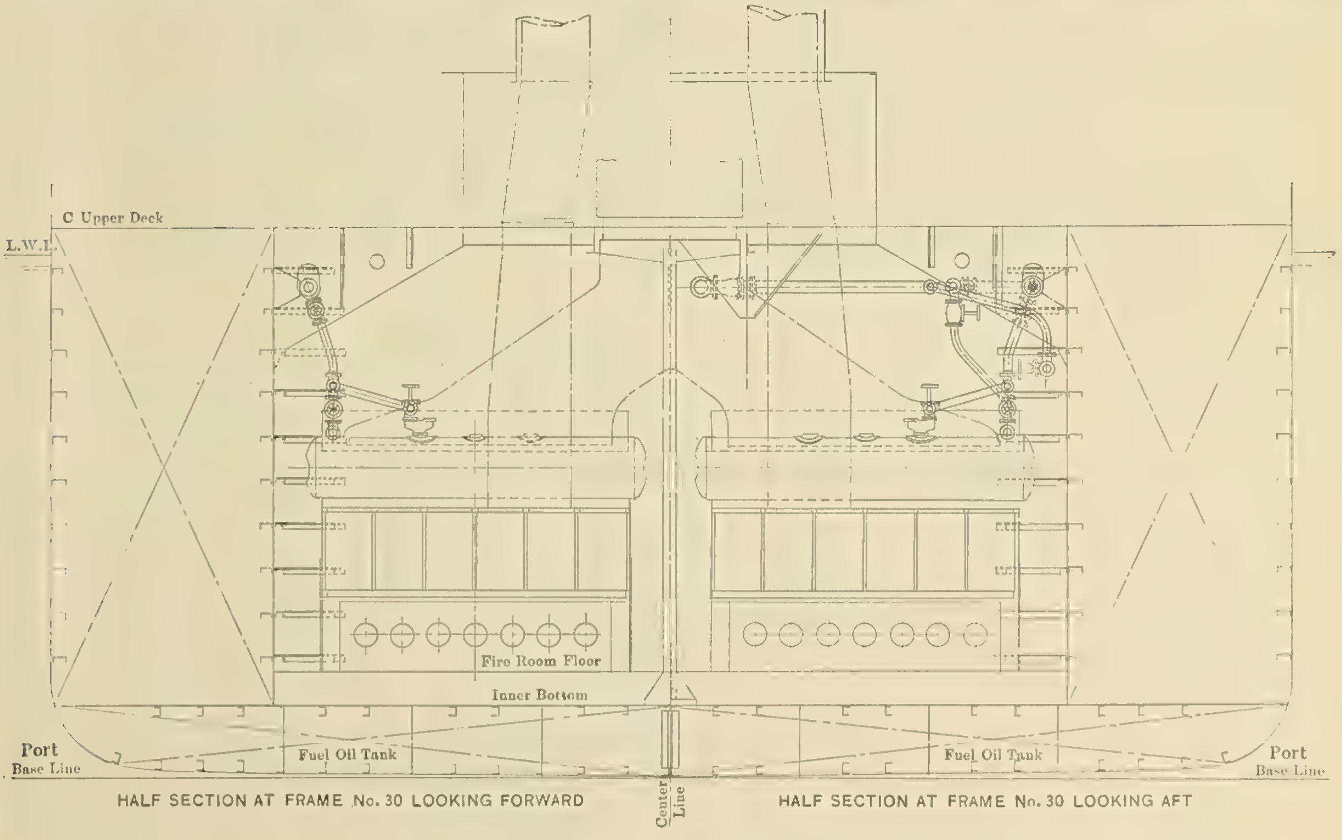


Fig. 9.—Section Through Boiler Room

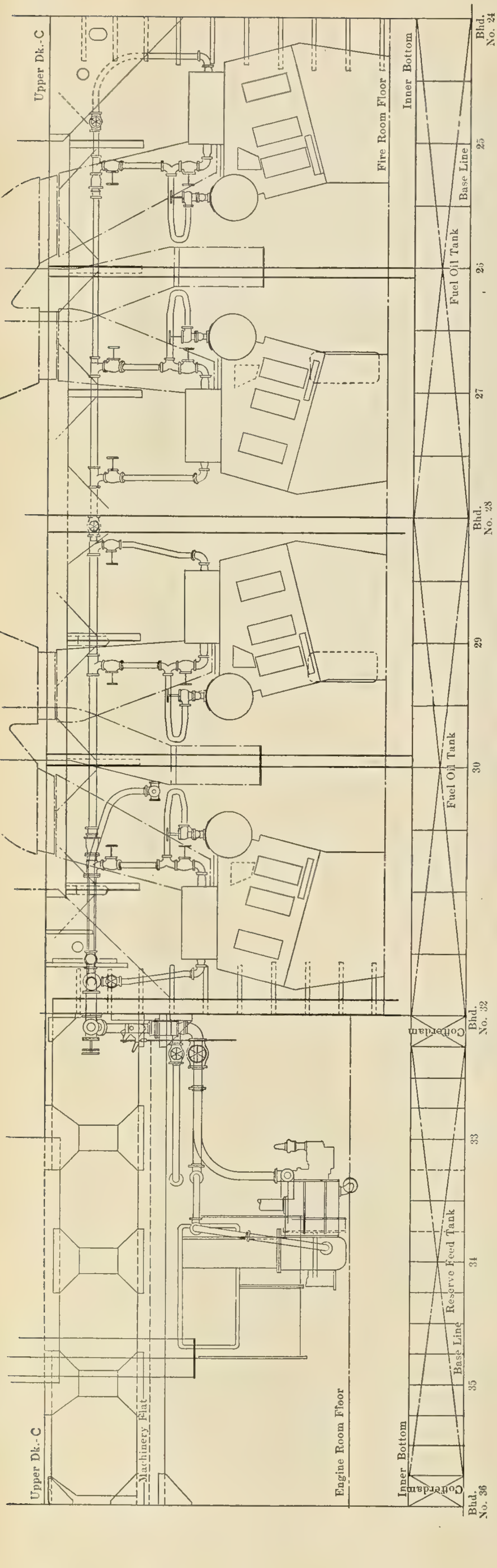


Fig. 10.—Longitudinal Section Through Machinery Space

The transverses, spaced 9 feet 6 inches apart and fitted with an angle face bar 6 inches by 4 inches by .70 inch throughout, are made up as follows:

	Side	*Deck*
Shade deck.......	18 inches by .44 inch	13 inches by .44 inch
Shelter deck......	20 inches by .44 inch	13 inches by .44 inch
Upper deck......	22 inches by .44 inch	13 inches by .44 inch
Main deck.......	31 inches by .50 inch	14 inches by .44 inch

The floors are .48 inch amidships, reduced to .42 inch at the ends and increased to .54 inch in the boiler space. The angles connecting the floors to the bottom and tank top plating are 3½ inches by 3½ inches by .52 inch to .48 inch.

For handling cargo there are five hatches 19 feet wide by 30 feet long; two 19 feet wide by 24 feet long and two 19 feet wide by 18 feet long. The hatches are served by thirty-two cargo booms of 6 tons capacity each, and one 30 ton boom. Hatches Nos. 2 to 8 inclusive are served by four booms each, while hatches Nos. 1 and 9 have but two booms each. Thirty-two 9¼-inch by 12-inch winches are provided, each capable of handling a load of 5 tons on a single whip.

Propelling Machinery

Propulsion is by twin screws, each 17 feet diameter, driven by two sets of double reduction geared turbines at a normal speed of 110 revolutions per minute. The turbines are of the Westinghouse double-flow type, designed to develop a total of 12,000 shaft horsepower. Each shaft has one high-pressure and one low-pressure turbine driving the propeller through a system of DeLaval double-reduction gears. Each turbine is installed forward of its own independent reduction gear, and each of these reduction gears is connected to its respective outboard or inboard pinion of a second reduction gear, which is installed at the forward end of the propeller shaft. With a steam pressure at the turbine chest of 250 pounds per square inch, and a vacuum of 28 inches at the turbine exhaust the turbines are designed to run at a speed of 3,630 revolutions per minute, driving the propeller at a speed of 110 revolutions per minute.

Steam is supplied at a working pressure of 265 pounds per square inch and 75 degrees superheat by eight oil-fired Babcock and Wilcox watertube boilers operated under the closed stokehold system of forced draft. With a bunker capacity of 3,267 tons of fuel oil the vessels will have a steaming radius at 17½ knots speed of 11,700 miles.

Engines for French Government

FOR several months past the National Marine Engine Works, Inc., Scranton, Pa., has been working on engine contracts for the French Government. In general, the triple-expansion inverted condensing engine of the type supplied to the Emergency Fleet Corporation has been required by the contracts.

This particular engine of 700 horsepower is built with cylinders 15½ inches, 26 inches and 44 inches diameter by 26 inches stroke. When completed in the shop, the engines are ready for installation in ships of the Lepar-mentier type built for the French Government by the Foundation Company at their New Orleans yard, for the thrust blocks, stern tube bearings, shafts and propellers, with the necessary fittings and spares, have been previously set up for test.

The engines are designed for 185 pounds per square inch working pressure, a vacuum of 26 inches, and to run at 115 revolutions per minute.

502-Foot Passenger and Cargo Vessels

Shipping Board Cargo Steamers with Limited Passenger Accommodations to Carry 12,000 Tons Deadweight at 14 Knots Speed

As a part of the Shipping Board program for overseas passenger and cargo service, the New York Shipbuilding Corporation, Camden, N. J., is building a number of twin screw 14-knot steamships of 12,000 tons deadweight capacity, which will have elaborate accommodations for 78 first-class passengers. The principal dimensions of these vessels are as follows:

Length overall	522 feet 5 inches
Length between perpendiculars	502 feet
Beam, molded	62 feet
Depth to "A" deck	42 feet
Draft, summer	31 feet 9 inches
Gross tonnage, about	10,500
Deadweight tonnage, about	12,000
Service speed	14 knots
Indicated horsepower	6,000
Fuel oil capacity	3,476 tons
Boiler feed water	215 tons
Domestic water	241 tons
Bale capacity	465,940 cubic feet
Ship's cold storage	5,300 cubic feet
Cargo cold storage	52,300 cubic feet
Number of first class passengers	78
Number of crew	115

These vessels are being classed by the American Bureau of Shipping. The accommodations, while limited to 78 first-class passengers, are very elaborate and lose nothing in comparison with the finest ships afloat. The passengers' staterooms and public rooms are situated on the "A," bridge and promenade decks. The general finish of the staterooms is white with mahogany trim. The beds are of square metal tubing, enameled to harmonize with the finish of the rooms. The public rooms are spacious and tastefully furnished and decorated. The dining saloon is finished in Colonial period; the smoking room in fumed oak, mission style; the social hall furniture and finish are of the Adams design. The general arrangement of the accommodations is shown on the plans reproduced herewith.

The equipment for handling cargo is unusually complete. In all there are nine large cargo hatches; five are 17 feet 6 inches by 25 feet, two are 19 feet by 20 feet, one is 18 feet by 15 feet, and one is 17 feet 6 inches by 15 feet. In addition there are two smaller hatches 8 feet by 15 feet, used for the refrigerated space. The cargo is

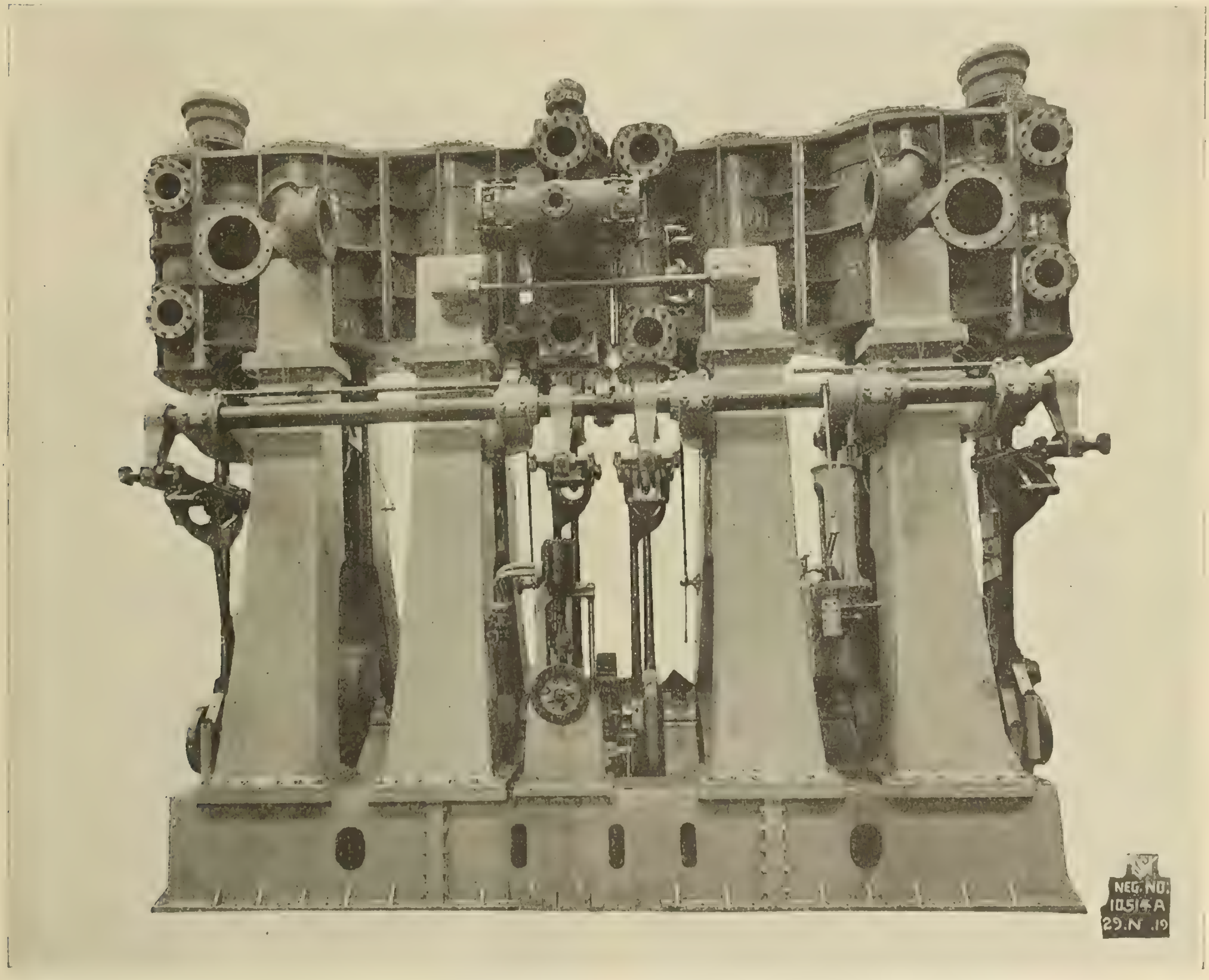


Fig. 1.—One of the Four-Cylinder, Triple-Expansion Main Propelling Engines of 3,000 Indicated Horsepower Built by the New York Shipbuilding Corporation for Installation on the 502-Foot Passenger and Cargo Vessels

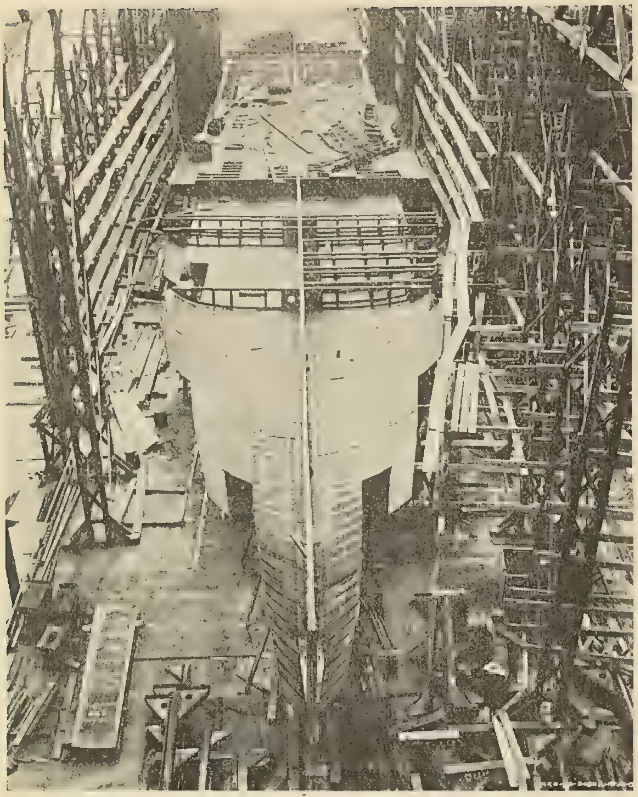


Fig. 2.—Bow View, Showing Double Bottom

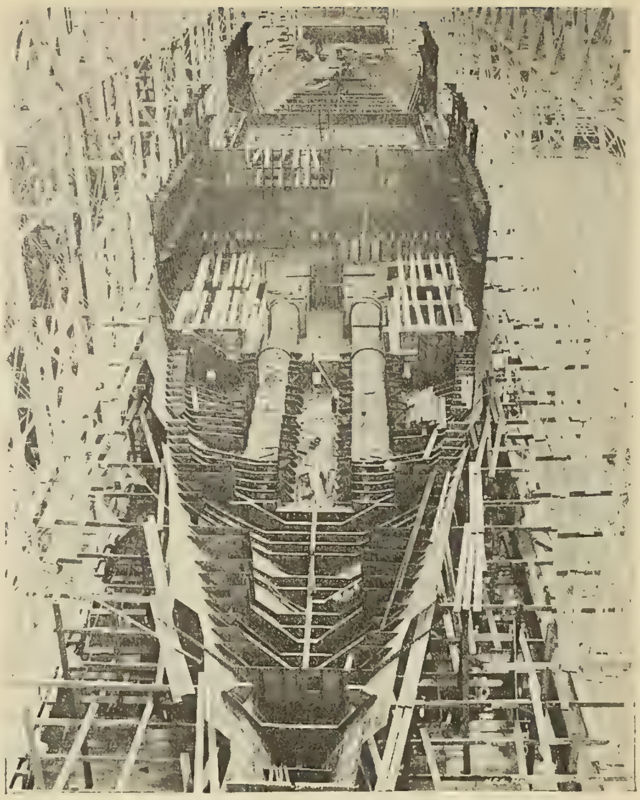


Fig. 3.—Stern View, Showing Framing

handled by thirty-two 6-ton booms, stopped to ten king-posts, and a 30-ton boom. The cargo handling equipment includes twenty steam winches, sixteen of which are of the 8¼-inch by 8-inch double cylinder, single drum, single geared, reversible type with one winch head and two other winches forward and two aft of the same size, but with two large winch heads each.

These vessels are built on the transverse system of framing with a double bottom throughout, and with the hull further subdivided into 14 watertight compartments by 13 transverse bulkheads, all of which extend up to the *A* deck.* Amidships the hull has no sheer. *B* and *C*

* For midship section and details of hull construction see MARINE ENGINEERING, April, 1919.

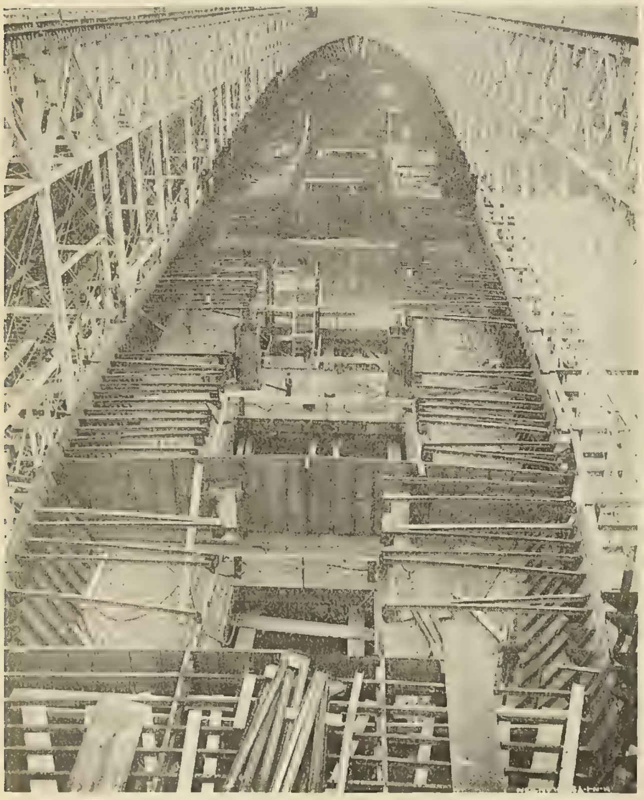


Fig. 4.—Stern View, Showing Bulkheads

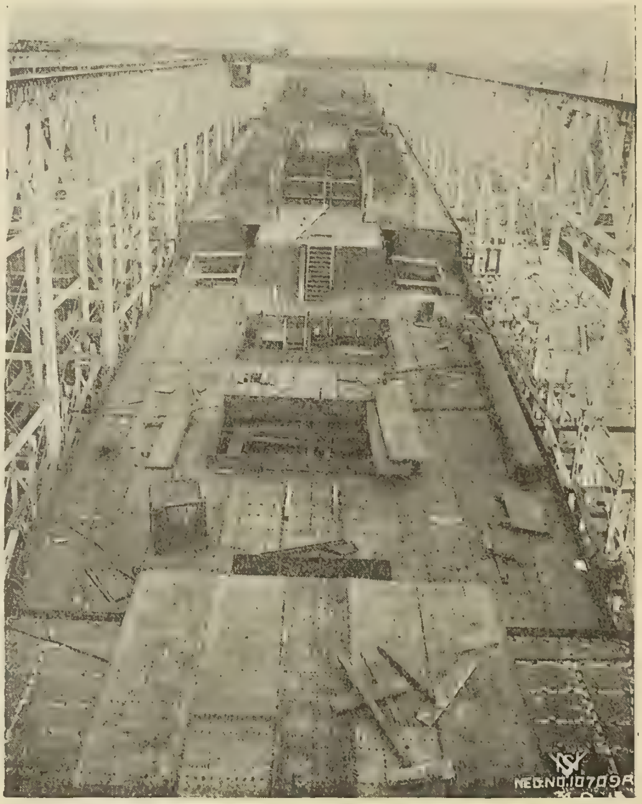


Fig. 5.—Stern View, Showing Weather Decks

502-FOOT PASSENGER AND CARGO VESSELS

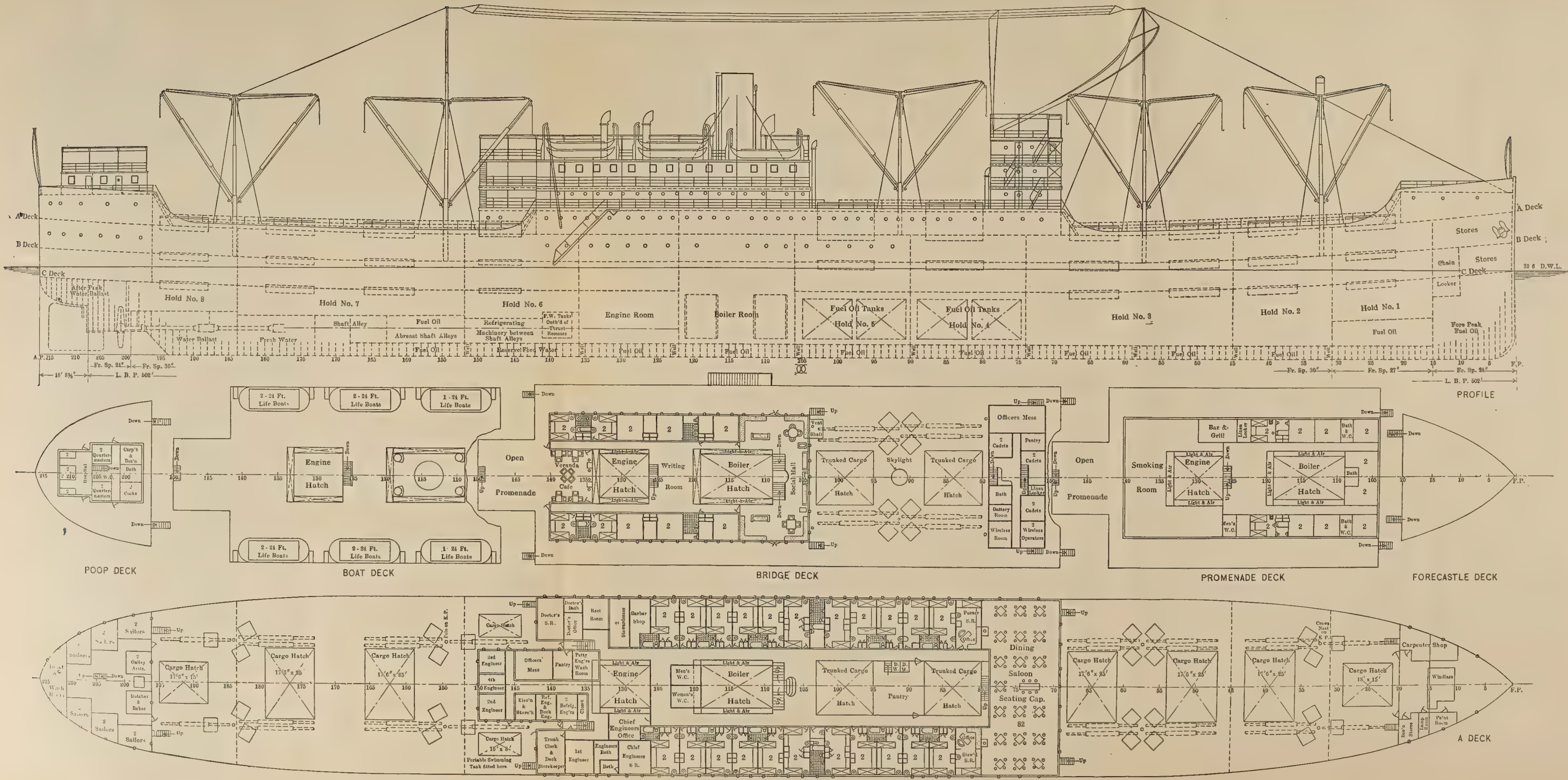


Fig. 6.—Profile and Deck Plans of 502-Foot, 14-Knot Ship

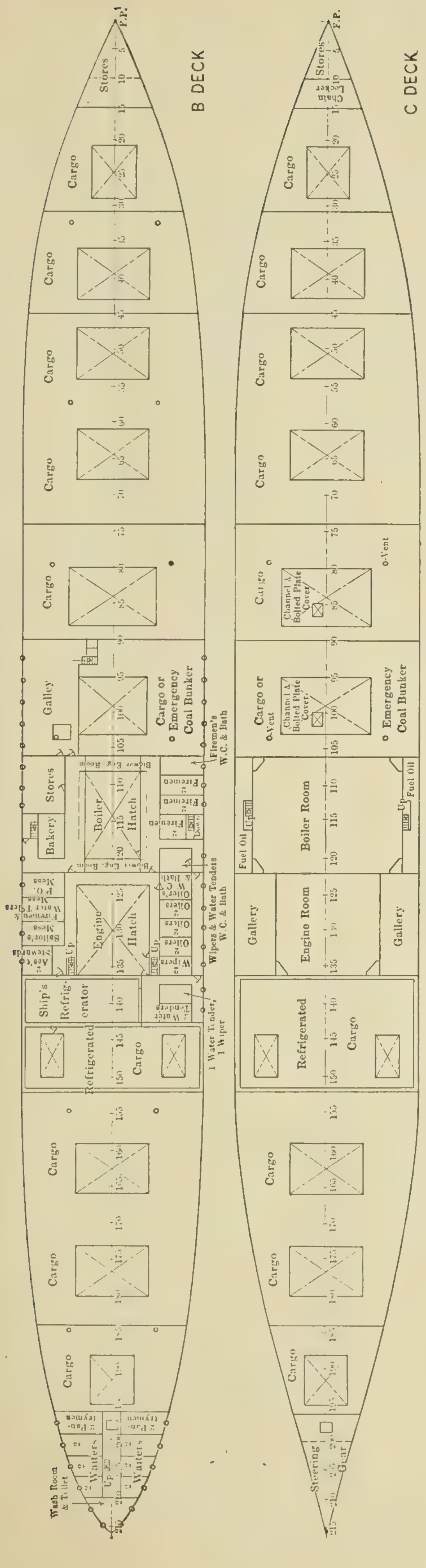


Fig. 7.—Plans of B and C Decks

decks have no camber, but all weather decks have a camber of 15 inches in 62 feet. The frames above the tank top are channels, except at the ends, where they are of angles with reverse frames. Solid floors are fitted in the double bottom on every third frame and beyond the double bottom on every frame. Double frames are fitted in the double bottom from three-fifths length forward to the collision bulkhead. Alternate frames of angles, bracketed to the bridge deck beams, are fitted in the bridge. All of the frames and reverse frames in the peaks run clear up to the poop and forecastle decks. The frames are cut and bracketed in way of all watertight flats and over fuel oil bunkers.

No web frames are fitted in the cargo holds, but two are fitted in the engine room, and others in the fuel oil bunkers in the boiler space as needed. The decks are all plated with steel with channel beams on every frame. The cargo holds are free of pillars, as the decks are supported by heavy girders.

Cold Storage Compartments

Ample cold storage space is provided as shown on the plans, there being separate compartments for meats and vegetables, etc. The former are to be maintained at 20 degrees F., and the latter at 40 degrees F. under tropical conditions. The walls and ceilings of the cold storage spaces consist of two thicknesses of ⅞-inch tongued and grooved yellow pine, two thicknesses of 2-inch cork, one thickness of ⅞-inch tongued and grooved yellow pine and finished on the inside with one thickness of ⅞-inch tongued and grooved spruce, each thickness of wood and cork being separated by two thicknesses of waterproof insulating paper.

In addition to the cargo winches already mentioned the deck machinery includes a steam windlass on the forecastle deck and steam, and hand-steering gear with telemotor control from the bridge.

Propelling Machinery

Propulsion is by twin screws of the built-up type, about 16 feet 6 inches diameter driven by two sets of four-cylinder, triple expansion, vertical, inverted reciprocating engines with cylinders 24 inches, 40½ inches, 54 inches and 54 inches diameter by 45 inches stroke, each of which is designed to develop at 105 revolutions per minute 3,000 indicated horsepower. Steam is supplied at 220 pounds per square inch by six oil-fired single-end Scotch boilers with a total heating surface of about 16,000 square feet working under a system of heated forced draft. The boilers are 15 feet 3 inches diameter by 11 feet 6 inches long between heads, each fitted with three 45-inch Morison corrugated furnaces leading to separate combustion chambers. The draft fans are driven by slow speed vertical single-cylinder reciprocating engines, of sufficient capacity to maintain a static pressure of 3 inches of water. The fuel oil is carried in bunkers fitted at the sides of the boiler space reaching from the tank top to *B* deck.

There are two independent main condensers, each with 4,500 square feet of cooling surface. Each condenser has a centrifugal circulating pump with 16-inch suction and discharge with a capacity of 5,000 gallons per minute against a head of 25 feet, driven by a single cylinder 10-inch by 10-inch vertical engine. The air pumps are of the vertical twin-beam type with one steam and two air cylinders 14 inches and 28 inches by 18 inches. There is also an auxiliary condenser with 1,000 square feet of cooling surface mounted on combined air and circulating pumps.

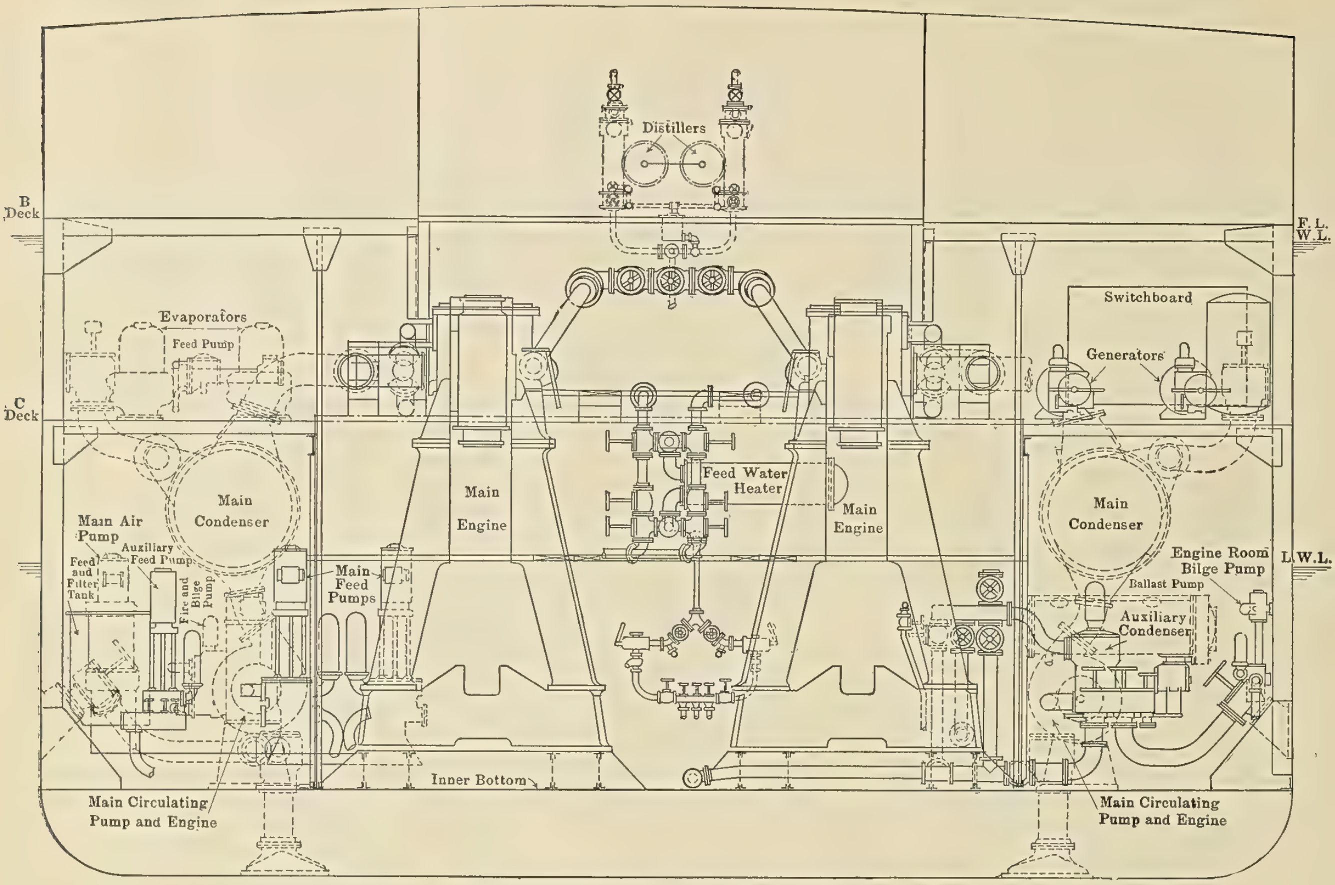


Fig. 8.—Section Through Engine Room

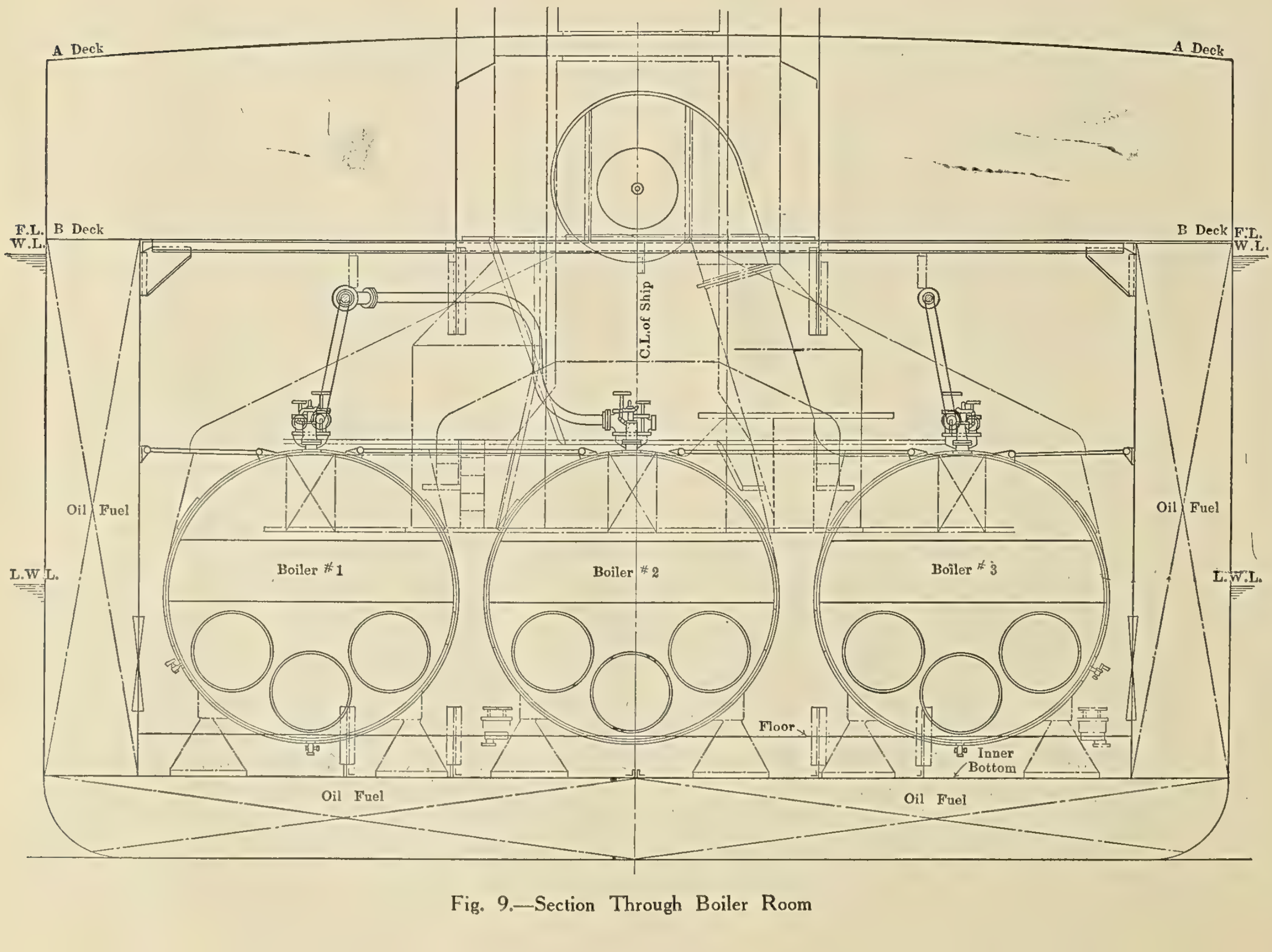


Fig. 9.—Section Through Boiler Room

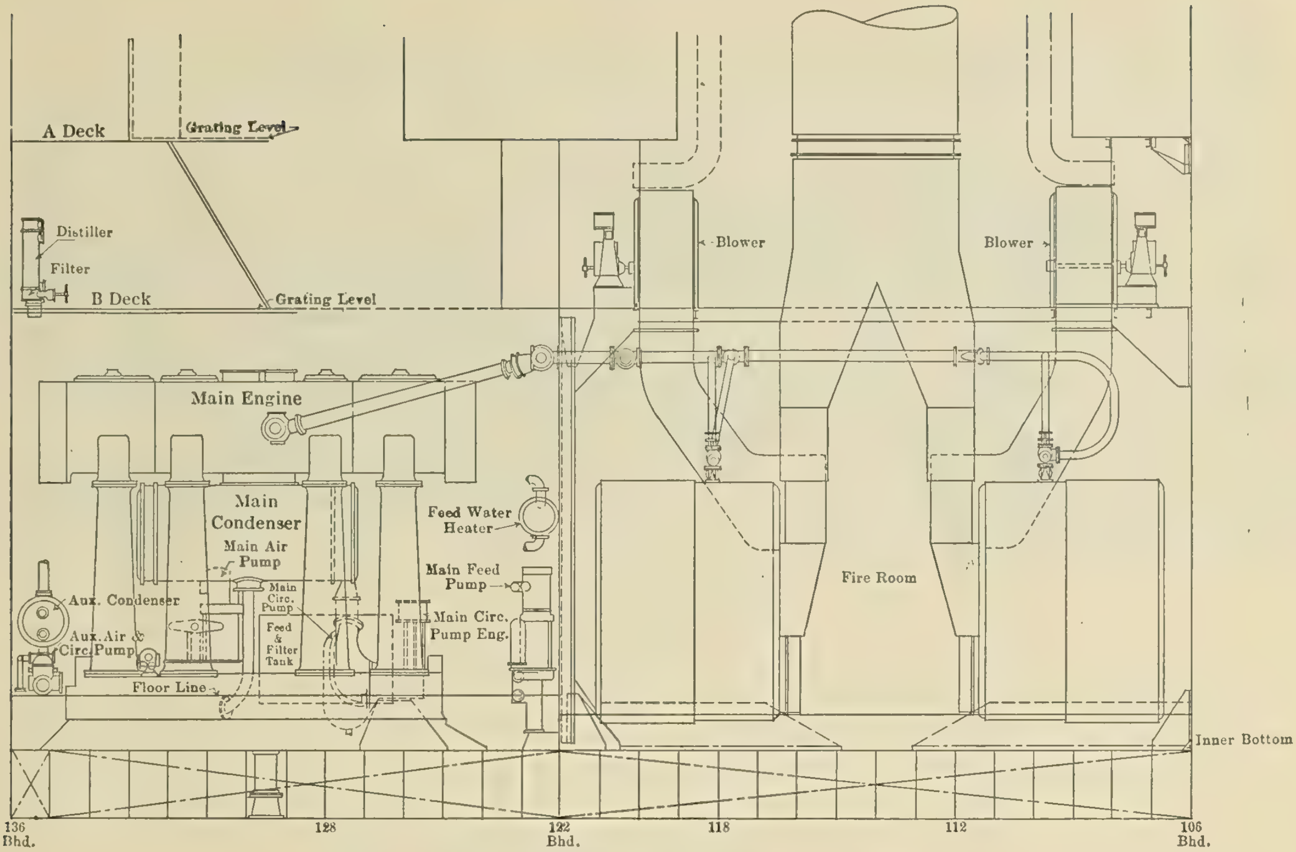


Fig. 10.—Longitudinal Section Through Machinery Space

Pumps

The following independent pumps are fitted:

Two main feed, 14 inches by 10 inches by 24 inches, vertical simplex.
One auxiliary feed, 10 inches by 7 inches by 24 inches, vertical simplex.
One ballast, 10 inches by 12 inches by 12 inches, horizontal duplex.
One fire and bilge and general service, 12 inches by 8 inches by 12 inches, horizontal duplex.
One sanitary, 7½ inches by 9 inches by 10 inches, horizontal duplex.
One engine room bilge pump, 6 inches by 7 inches by 12 inches, vertical simplex.
Two fresh water, 7½ inches by 6 inches by 10 inches, horizontal duplex.
One drinking water 4½ inches by 3¾ inches by 4 inches, horizontal duplex.
One evaporator feed, 7½ inches by 6 inches by 10 inches, horizontal duplex.
One auxiliary and circulating, 10 inches by 12 inches by 14 inches by 12 inches, horizontal simplex.
One oil transfer, 7½ inches by 9 inches by 10 inches, vertical duplex.
Two oil service, 7½ inches by 4½ inches by 10 inches, vertical duplex.
One ice machine condenser circulating, 6 inches by 5¾ inches by 6 inches, horizontal duplex.
One brine circulating, 6 inches by 5¾ inches by 6 inches, horizontal duplex.

The auxiliary machinery also includes a feed water heater with a capacity for heating 125,000 pounds of feed water per hour from 90 to 212 degrees F. when using exhaust steam at a pressure of 5 pounds per square inch gage; two 25-ton evaporators; two distillers, each with a capacity for distilling 3,000 gallons of water per 24 hours, and a feed and filter tank of 1,400 gallons capacity in the engine room.

100-Foot Wooden Harbor Tugs

A LARGE number of 100-foot wooden harbor tugs were built during the war, and since the war several additional vessels of this type are being constructed by such representative shipyards as those of the Consolidated Shipbuilding Corporation, Morris Heights, New York, Northwest Engineering Works, Green Bay, Wis., the Leathem and Smith Towing and Wrecking Company, Sturgeon Bay, Wis., the Gibbs Gas Engine Company, the John H. Mathis Company, Camden, N. J., etc. The plans published herewith show the design for this

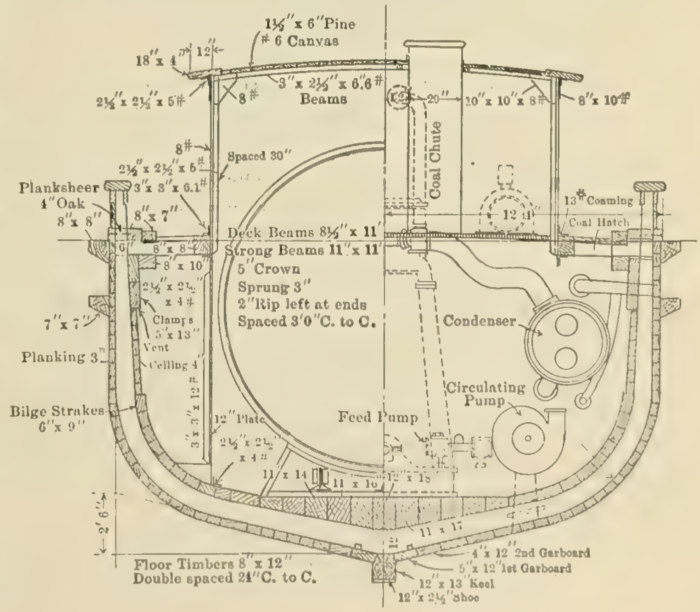


Fig. 1.—Midship Section, 100-Foot Tug

Fig. 2.—Launching of Tug *Condor*

type of vessel developed by J. Murray Watts, naval architect, Philadelphia, Pa., for the United States Shipping Board. Forty-two of these tugs have so far been built according to these designs, and the photographs show (in Fig. 5) the tug *Energy*, as completed by the Northwest Engineering Works, (in Fig. 2) the launch of the *Condor*, by the Gibbs Gas Engine Company; and (in Fig. 4) the *Hawk*, under construction by the Gibbs Gas Engine Company.

These boats are strongly built of wood with oak frames

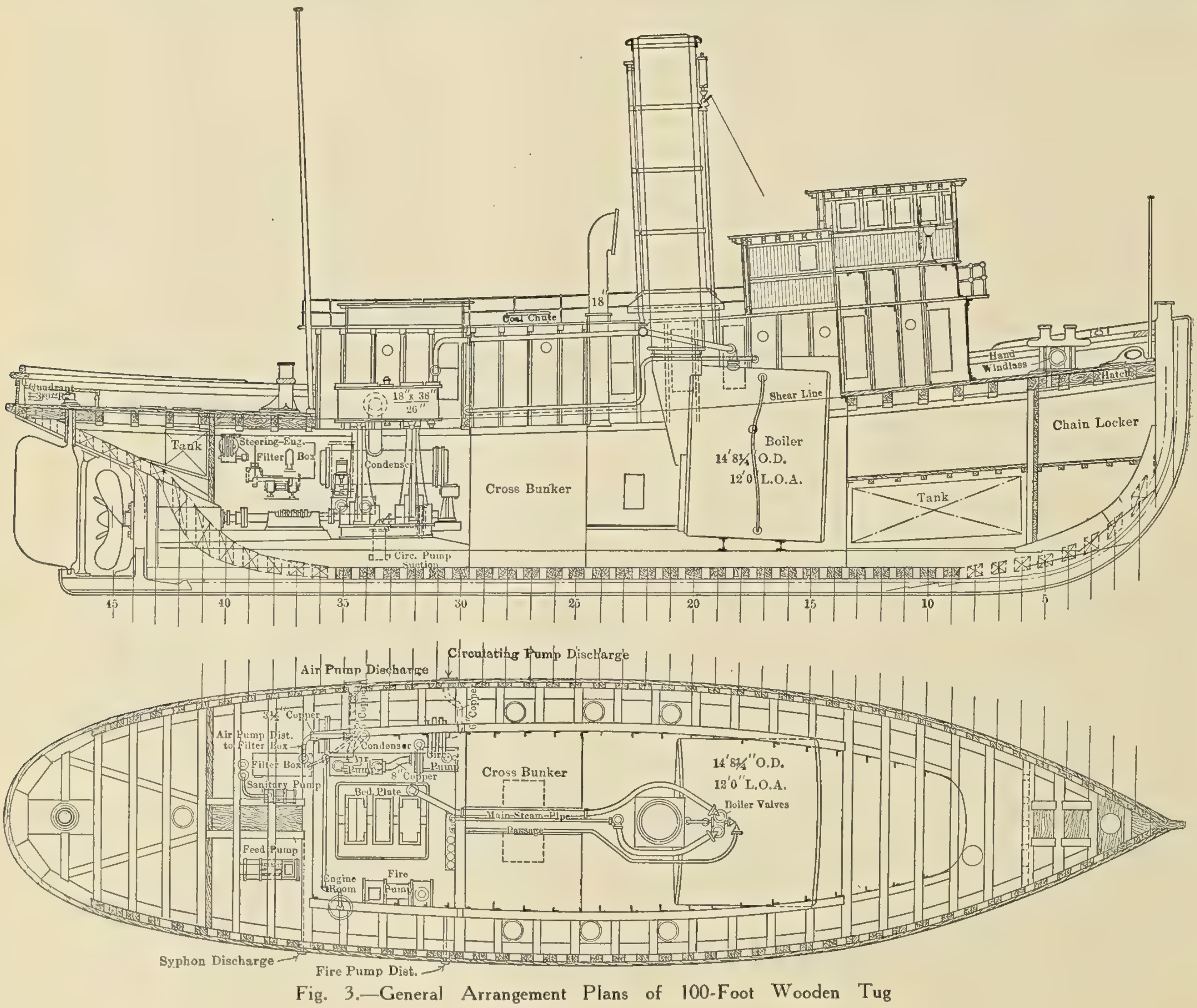


Fig. 3.—General Arrangement Plans of 100-Foot Wooden Tug

Fig. 4.—Wooden Tug *Hawk* Under Construction

and hard pine planking. The main bulkheads are of steel and the pilot house of wood. The principal dimensions of the tugs are as follows:

Length overall	100 feet 8 inches
Length between perpendiculars	94 feet 10 inches
Beam, molded	24 feet
Depth, molded	14 feet 7 inches
Draft, aft	13 feet 2 inches
Draft, forward	12 feet 3 inches

The keel is of oak, 12 inches by 15 inches; the planking, of hard pine, varies from 5 inches to 3 inches in thickness; the frames are of oak, 8 inches by 12 inches, spaced 24 inches between centers. The keelsons are built up of 11-inch and 12-inch hard pine. Special care has been taken in the specifications to insure the best of fastenings throughout, with the result that the boats have shown up well under rigid tests.

The general arrangement, as shown in the plans, provides quarters for the crew forward with berths and lockers for eight men. A ladder leads from these quarters to a companionway in the forward end of the deckhouse. The boiler and the coal bunkers are amidships, and the engine room aft. In the main deckhouse there is a galley and mess room forward, a pilot room and a lamp room amidships, and two double staterooms forward of the engine room. On top of the deckhouse is the pilot house, and behind the pilot house the captain's cabin.

Propulsion is by a four-bladed propeller 9 feet in diameter and 12 feet pitch, driven by a vertical compound engine with cylinders 18 inches and 38 inches in diameter by 26 inches stroke supplied with steam at a pressure of 155 pounds per square inch, by one Scotch boiler, 14 feet 6 inches diameter and 12 feet long, having a heating surface of 2,506 square feet and a grate area of 747 square feet.

The following figures represent the average performance of one of these tugs during the trial trip:

Revolutions per minute of main engine	88
Steam pressure at boiler, pounds per square inch	148
Steam pressure at engine, pounds per square inch	146
Vacuum, inches	25.5
Revolutions per minute of feed pump	9
Revolutions per minute of circulating pump	200
Revolutions per minute of air pump	52
Temperature of feed heater, degrees F.	220
Temperature of filter box, degrees F.	110
Temperature of sea suction, degrees F.	70
Temperature of condenser discharge, degrees F.	102

Fig. 5.—Tug *Energy*, Built by Northwest Engineering Works

10,000-Ton Oil Tank Steamship

Description of Vessels Building By Merchant Shipbuilding Corporation for Union Oil Company of California

THE Union Oil Company of California has ordered a fleet of four 10,000-ton oil tankers from the Merchant Shipbuilding Corporation, which are being built at the Chester, Pa., yard of this company. The vessels are of the steel single-screw type with the machinery aft. The hull is longitudinally framed on the Isherwood system. Cargo oil will be carried in nine main tanks and in four summer tanks on the port and starboard sides of the vessel.

The general design, as shown in the illustrations, calls for a vessel fitted with a long poop, short bridge, and forecastle arranged for crew accommodations, stores, etc. The officers are housed in a steel house on the bridge deck, the captain in a steel house on the boat deck, with a wooden wheel house and chart room above. The principal dimensions are as follows:

Length overall	439 feet 7 inches
Length between perpendiculars	424 feet
Beam, molded	58 feet
Depth at side to upper deck	33 feet
Draft, designed load	25 feet 5 inches
Displacement, at designed load draft	14,360 tons
Deadweight tonnage	10,000 tons
Speed, designed, at load draft	10½ knots
Deadweight, at designed load draft	10,000 tons
Cargo capacity, main tanks, including expansion trunk, about	380,000 cubic feet
Cargo capacity, summer tanks, about	55,000 cubic feet
Fuel oil capacity, at 38 cubic feet per ton, about	1,350 tons
Drinking water tanks, about	29 tons
Reserve feed water, about	200 tons
Package freight holds, bales, about	30,000 cubic feet

Hull Construction

As shown by the general plans a double bottom is fitted under the engine and boiler rooms only, and is used for

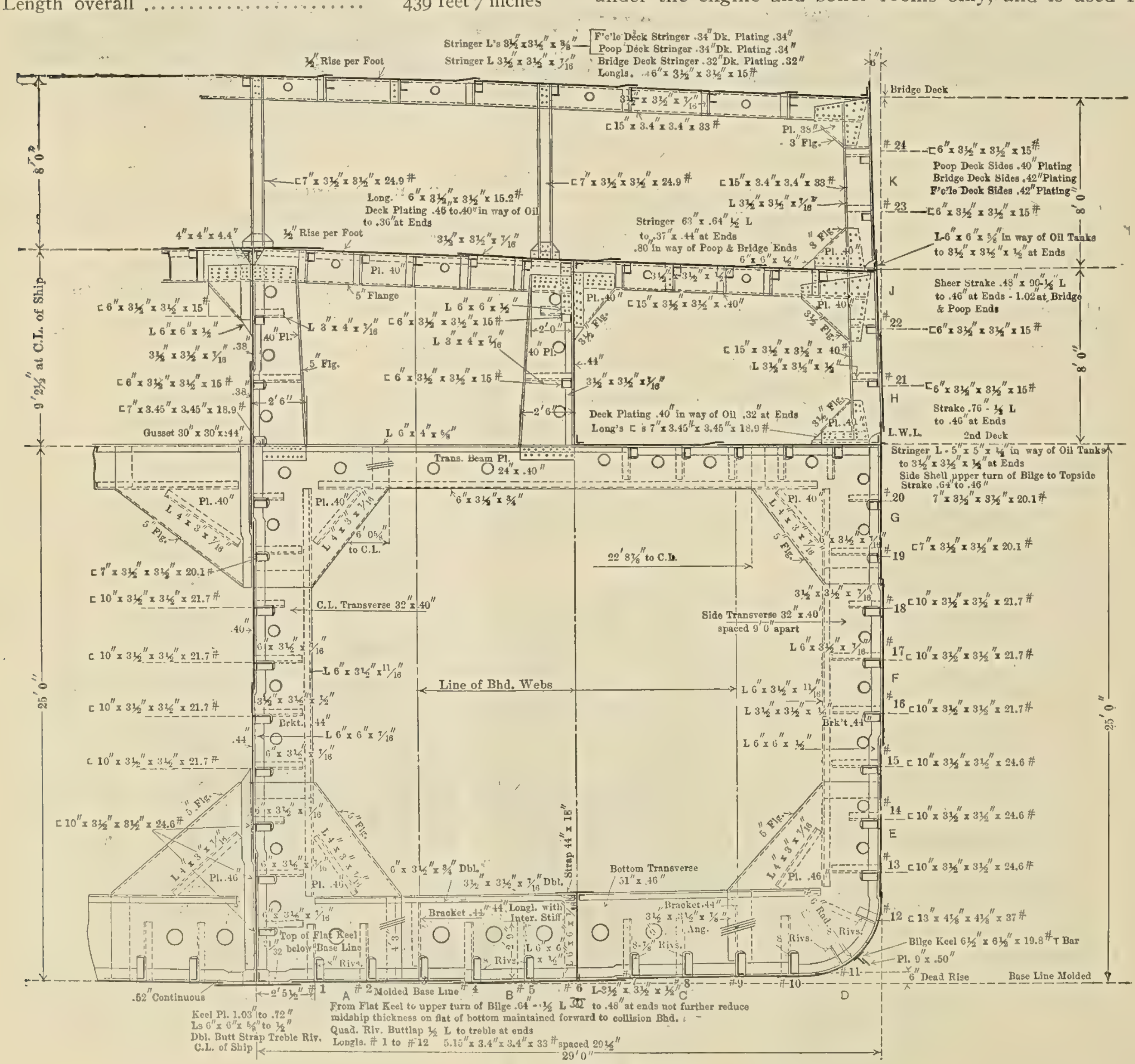


Fig. 1.—Midship Section

INTE

OIL TANKER OF 10,000 TONS DEADWEIGHT

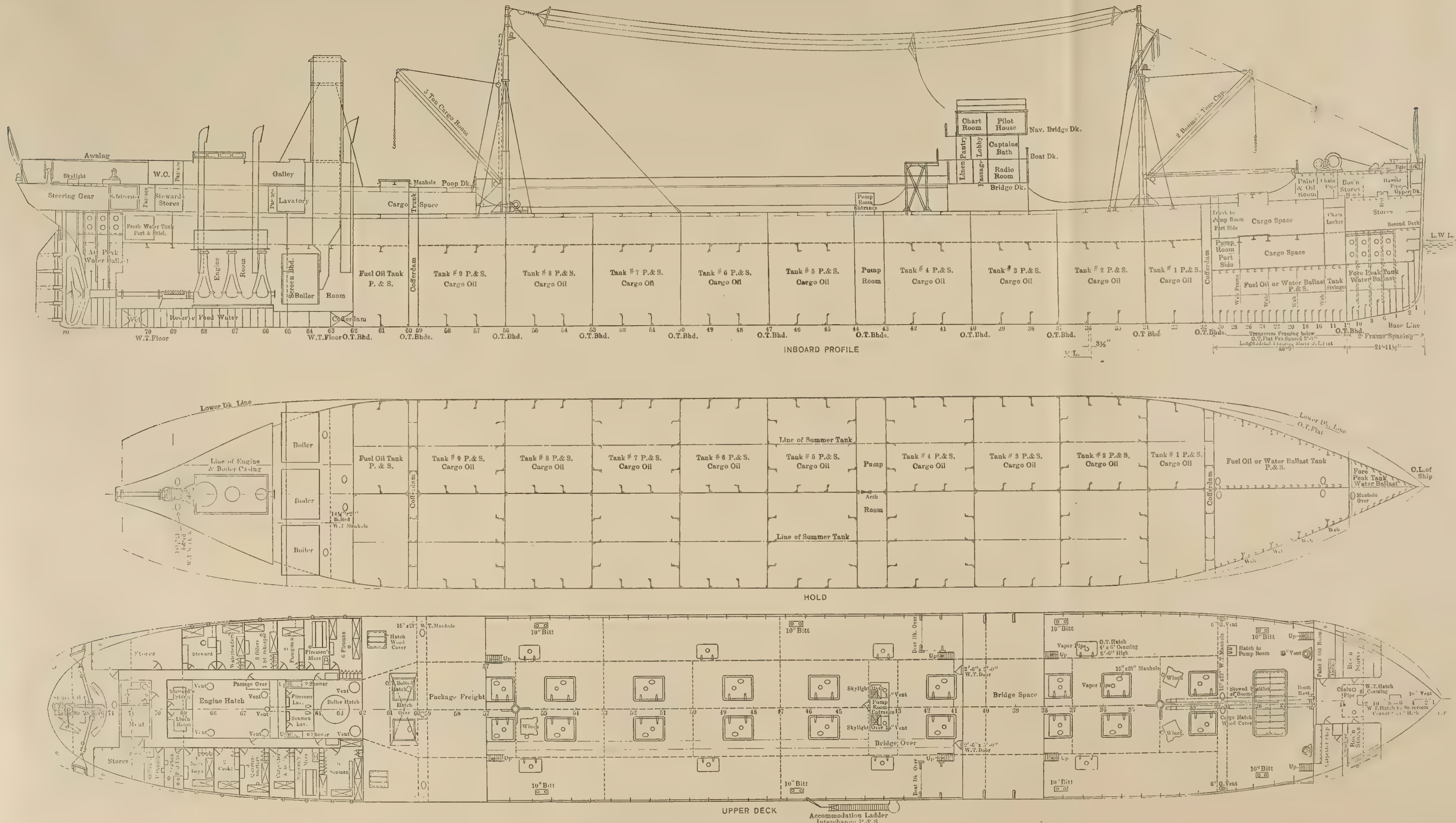


Fig. 2.—Profile and Deck Plans of 10,500-Ton Tanker

THE Union
fleet of
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The hull is long
Cargo oil will
summer tanks
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The general
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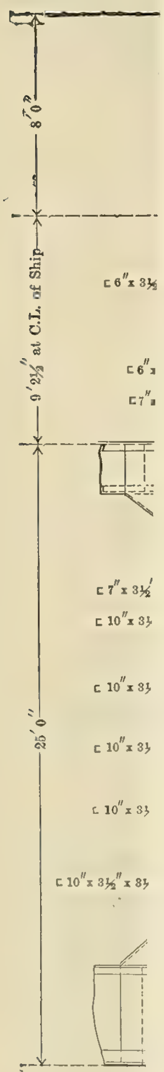
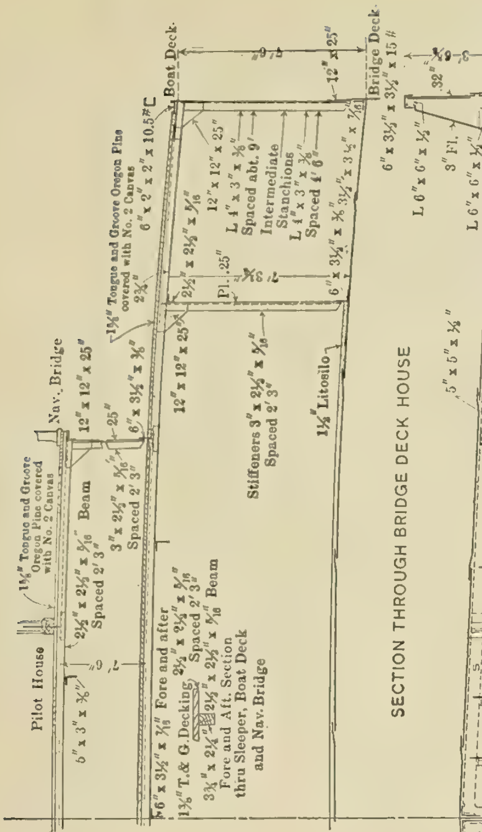
Length overall .





SECTION THROUGH BRIDGE DECK HOUSE

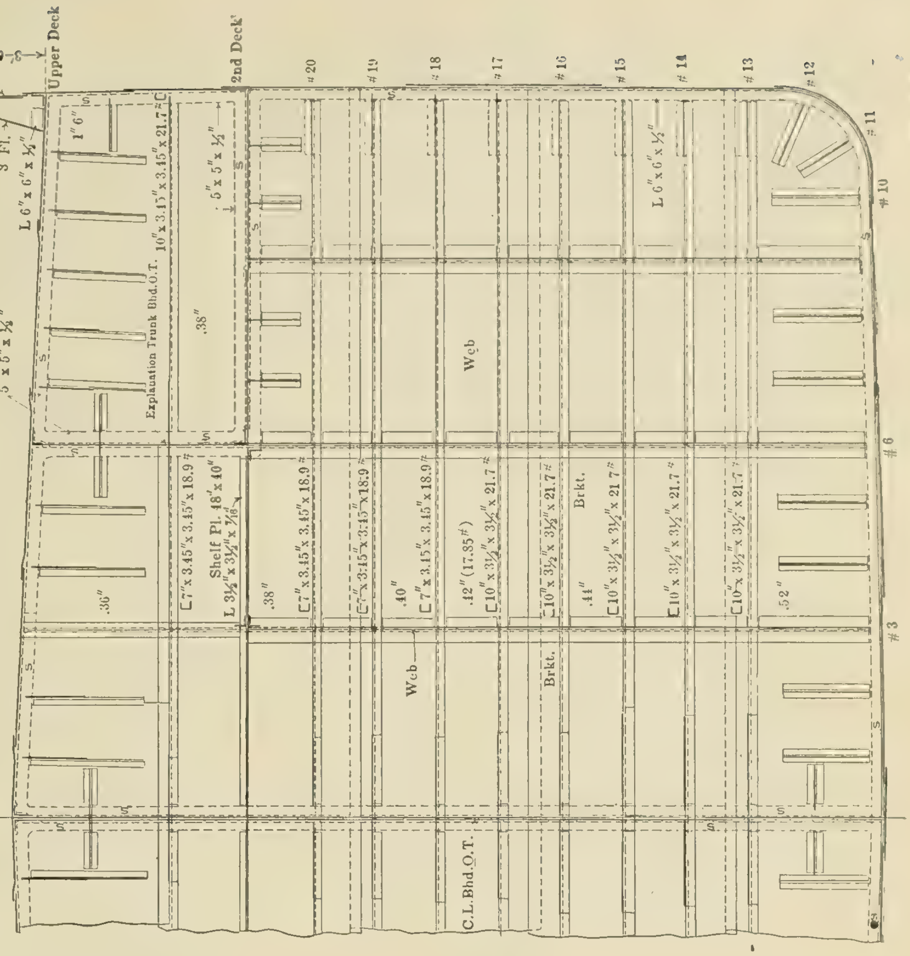


Fig. 8.—Typical Oil-Tight Bulkhead

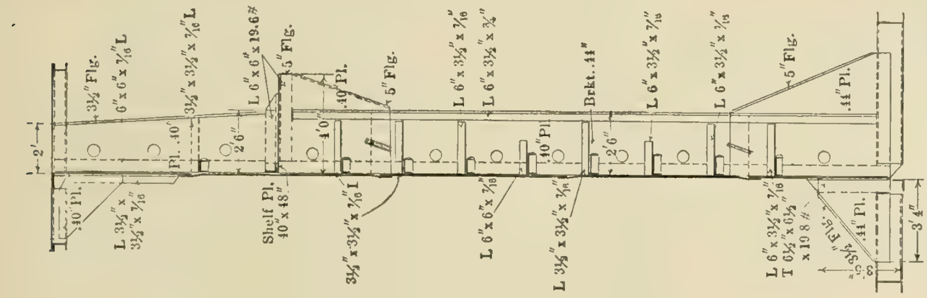


Fig. 7.—Inboard Vertical Stiffener

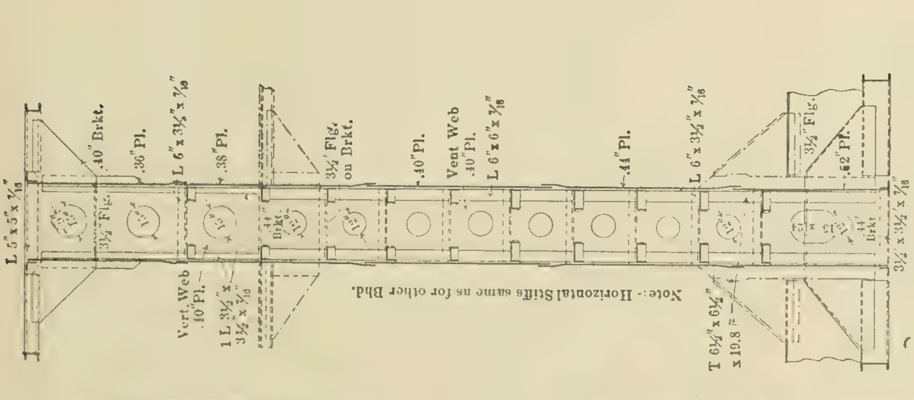
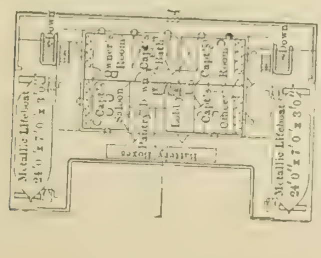
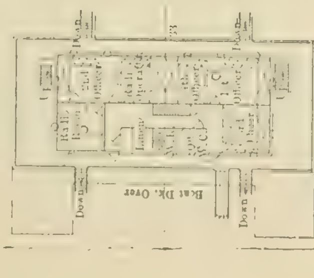


Fig. 6.—Cofferdam Bulkhead



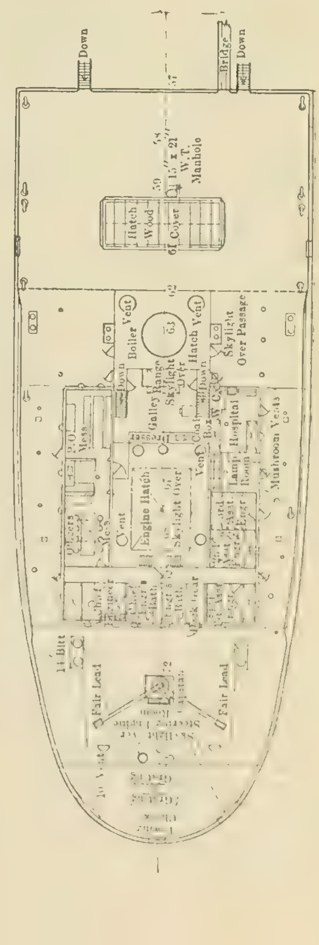
BOAT DECK

Fig. 3



BRIDGE DECK

Fig. 4



POOP DECK

Fig. 5

reserve feed water. The fuel oil is carried in a deep tank forward of the boiler room. This is separated from the aft cargo oil tanks by a cofferdam. Similarly the forward cargo oil tanks are separated by a cofferdam from the package freight hold, under which is a deep tank fitted for fuel oil or water ballast. The peak tanks are fitted for ballast. Additional package cargo space can be provided at the forward end of the poop. The main pump room is located between Nos. 4 and 5 main tanks, and a small pump room is located forward of the forward cofferdam between the oil-tight flat and the lower deck.

Hatches are provided for each oil tank and for the package holds forward and aft, as shown on the plans. The vessel is schooner-rigged with two steel pole masts. On the forward side of the foremast are fitted two five-ton wooden cargo booms, each 45 feet long. On the after side of the main mast is a single wooden cargo boom, 47 feet long, capable of lifting five tons.

The main scantlings of the hull are as shown on the midship section. The vertical keelson is continuous throughout from peak bulkhead to peak bulkhead and is oil-tight, except in the machinery spaces, where it is substantially tight. From the top of the vertical keel to the top of the tanks throughout the length of the cargo and fuel oil tanks extends an oil-tight centerline bulkhead.

A continuous expansion trunk is fitted between the second and upper decks for all main oil tanks. The trunk bulkheads extend through the after oil bunkers and are connected to the boiler casing.

Transverses are spaced as shown on the plan, generally 9 feet between centers. Under the boilers they are spaced 6 feet 9 inches with an intermediate transverse under the engine. Transverse floors are fitted in the peak tanks, spaced 24 inches between centers.

Electric Welding

In building the vessels the following parts may, at the builders' option and subject to the approval of the classification society, be electrically welded instead of riveted.

Gutter bars at oil bulkheads.

Clips and angles on bulkheads, etc., for engine and boiler room floor plates.

Bathroom, galley and miscellaneous fixtures.

Gasket angles, covers, etc., metal doors and covers.

Engine room and other metal skylights and covers.

Non-structural tanks.

Smokestack.

Uptakes.

Ventilator deck angles to vent cowls.

Bulkheads, trunks, etc., not forming part of the strength members of the vessel.

Slop chute.

Sheet metal work in general when of black iron.

Masts.

Two cold storage rooms are provided on the upper deck in the engine hatch. One of these is the meat room of about 550 cubic feet capacity, and the other the provision room of about 340 cubic feet capacity.

Propelling Machinery

Propulsion is by single-screw of the four-bladed built-up type, about 17 feet diameter, driven by a vertical inverted triple expansion surface condensing engine with cylinders 27 inches, 45 inches and 75 inches diameter by 51 inches stroke. The three cranks are set at angles of 120 degrees and the cylinders are arranged with the high pressure forward and the low pressure aft. The high and intermediate-pressure valves are of the piston type, while the low-pressure cylinder has a balanced slide valve.

The main condenser, which is independent of the main engine, has a cooling surface of 4,000 square feet. The main air pump, together with two bilge pumps, is driven direct from the low-pressure crosshead of the main engine. The circulating pump is of the centrifugal double-suction type of 5,500 gallons per minute capacity, driven by a vertical single-cylinder reciprocating engine, operating with steam at 100 pounds pressure.

The main crankshaft and crank pins are 15⅛ inches diameter; the thrust shaft 15¼ inches diameter under the collar, and the propeller shaft 15½ inches diameter.

Boilers

Steam will be supplied at a pressure of 200 pounds per square inch by three single-end Scotch boilers 15 feet 3 inches inside diameter by 11 feet 6 inches long over the heads, each with a total heating surface of 2,750 square feet. Each boiler has three Morrison corrugated furnaces, 45 inches inside diameter, leading to separate combustion chambers.

The boilers are fitted for burning oil and burners of the mechanical atomizing type will be fitted, having a total maximum capacity of 3,700 pounds of fuel oil per hour. The fuel oil is handled by two horizontal duplex double-acting pumps 5¼ inches by 3½ inches by 5 inches, with the suction connected to the after fuel oil deep tank, and the discharge (through fuel oil heaters and strainers) to the burners. A fuel-oil transfer and ballast pump is also fitted, with suction from the forward fuel tanks port and starboard, discharging to the after fuel tank. This pump is 7 inches by 7 inches by 10 inches. Steamheating coils are fitted in all fuel oil tanks, as well as in all cargo oil tanks.

A vertical donkey boiler 48 inches diameter by 96 inches high, with about 330 square feet of heating surface, is installed in the fire room. This boiler will burn coal and supply steam at a pressure of 100 pounds per square inch.

Auxiliaries

The engine and fireroom auxiliaries include a forced draft blower of the steel-plate type, with a capacity of 22,000 cubic feet of air per minute at 100 degrees Fahrenheit, direct connected to two single cylinder vertical engines, one on each side of the fan casing. Two feed pumps are provided of the vertical simplex double-acting type, 12 inches by 8 inches by 24 inches. The feed water heater has a capacity for heating 49,000 pounds of water per hour from 90 to 215 degrees Fahrenheit, with five pounds steam pressure on the shell.

The equipment also includes a 30-ton evaporator with a horizontal duplex double-acting feed pump 4½ inches by 4 inches by 4 inches, and a fresh water distiller with a capacity of 2,000 gallons per twenty-four hours, with circulating water at 80 degrees Fahrenheit.

The auxiliary condenser has 7,000 square feet of cooling surface, and is mounted on a combined air and circulating pump 10 inches by 12 inches by 12 inches by 12 inches.

The electric plant consists of two 10-kilowatt direct-connected generators, driven by vertical reciprocating engines. A 2-ton refrigerating machine of the ammonia type is installed.

The pumps also include the following: One fresh water pump, 4½ inches by 3¾ inches by 4 inches, horizontal duplex; one salt water sanitary, 6 inches by 6 inches by 10 inches, horizontal duplex; one donkey pump, 12 inches by 10 inches by 12 inches, horizontal duplex; one bilge, 6 inches by 5 inches by 6 inches, horizontal duplex; and one hand fire and bilge, 6 inches by 5¼ inches, single cylinder.

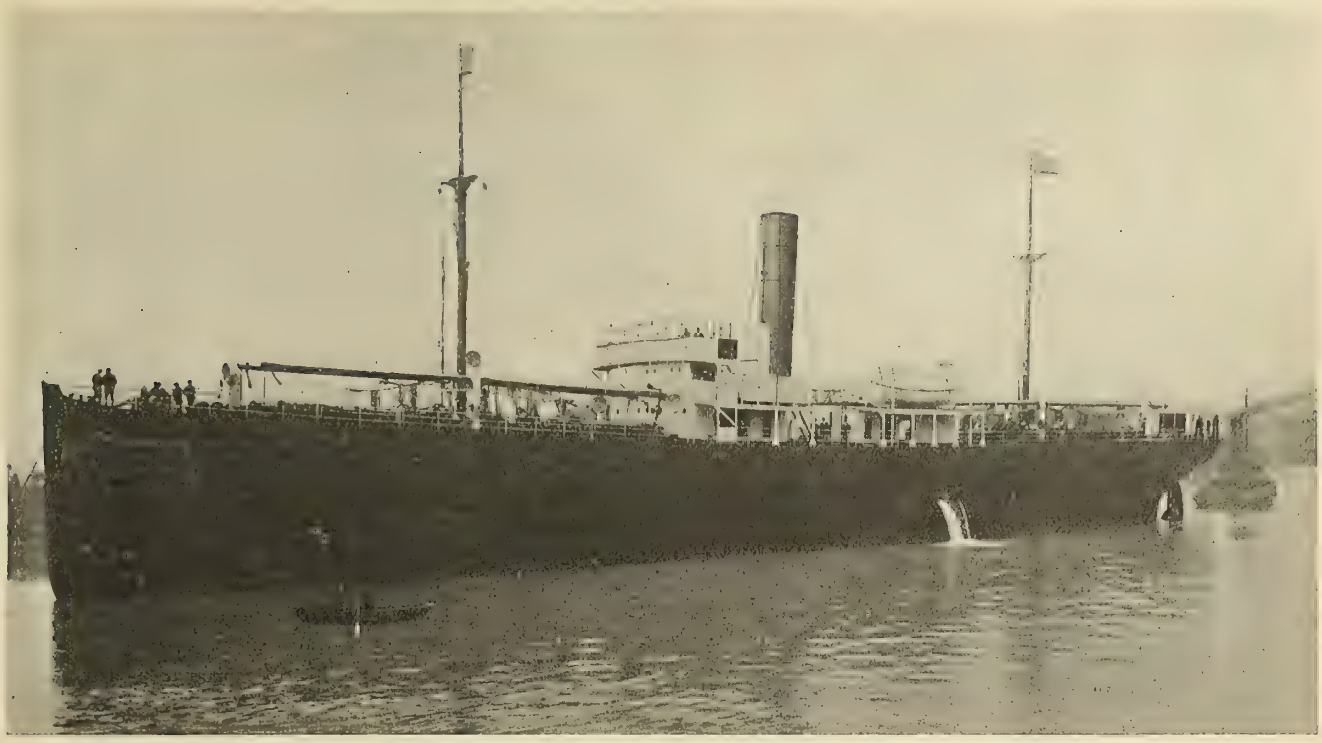


Fig. 1.—Eight Ships of the *Cervantes* Type Have Been Built in Great Britain in Pursuance of the Policy of Ship Standardization

British Standard Ship of 3,150 Tons D. W.

Cargo Ships of Standard Design Being Developed by the Shipbuilders in Great Britain to Replace War Losses in Vessel Tonnage

BY MAJOR FREDERICK C. COLEMAN

As in the United States, the problems of ship standardization have received great attention in the United Kingdom for the past two or three years, and every effort has been made to place shipbuilding on the production basis so necessary quickly to replace the tonnage losses of the war. The entire programme of standard ship construction has been in the hands of the British Shipping Controller, who has enlisted the co-operation of practically every shipyard in the country. Fabricating processes have not reached the advanced stage that they have in the United States, but the number of standard ships turned out in British yards is increasing rapidly.

Among others who have given the matter of standardization special consideration is the firm of Messrs. H. & C. Grayson, Ltd., of Liverpool. Eight vessels of a single type have so far been built and delivered from the Liverpool yards of this company, and a large number are now on the ways. Five of the earlier vessels were acquired by the British Shipping Controller, and three of these, the *Cervantes,* the *Colon* and the *Ciscar,* were subsequently allocated to Messrs. R. MacAndrew & Company, Ltd., London.

Principal Dimensions of Cervantes Type

These vessels are of the shelter deck type, having the following principal dimensions:

Length overall	275 feet
Length between perpendiculars	265 feet
Breadth amidships	41 feet
Depth to upper deck	21 feet
Depth to shelter deck	28 feet 10 inches
Extreme draft	20 feet 2 inches
Deadweight capacity at above draft	3,150 tons
Block coefficient	0.75

Hold and Bunker Capacity

The total grain carrying capacity of each vessel is 176,126 cubic feet, which is divided between the fore and after holds and the fore and after 'tween decks. The total bunker capacity is 582 tons of coal, 254 tons of which is below the upper deck and the remainder on the 'tween decks and shoots. The water ballast in No. 1 double bottom is 207 tons; in No. 2 double bottom, port, 45.5 tons; No. 2 double bottom, starboard, 45.5 tons, and No. 3 double bottom, 110 tons, making a total of 408 tons in the double bottoms. Water ballast in the fore peak amounts to 63 tons, and in the aft peak to 17.5 tons, making a total water ballast of 488.5 tons. Tonnage under the deck amounts to 2,330 tons, while the gross tonnage is 2,436 and the net tonnage 1,508. These tonnages include the 'tween decks, the tonnage hatch having been built up as an ordinary hatch.

Double Bottom

The double bottom, 3 feet deep, is continuous from peak to peak, and is constructed on the cellular system with a solid floor on every frame. It is divided into three compartments, one under the fore hold, another under the engine and boiler room, and a third under the after hold. The compartment under the engine and boiler room is further divided by the watertight center girder. The peaks are also arranged to carry water ballast, or, when necessary, fresh water for boiler feed water.

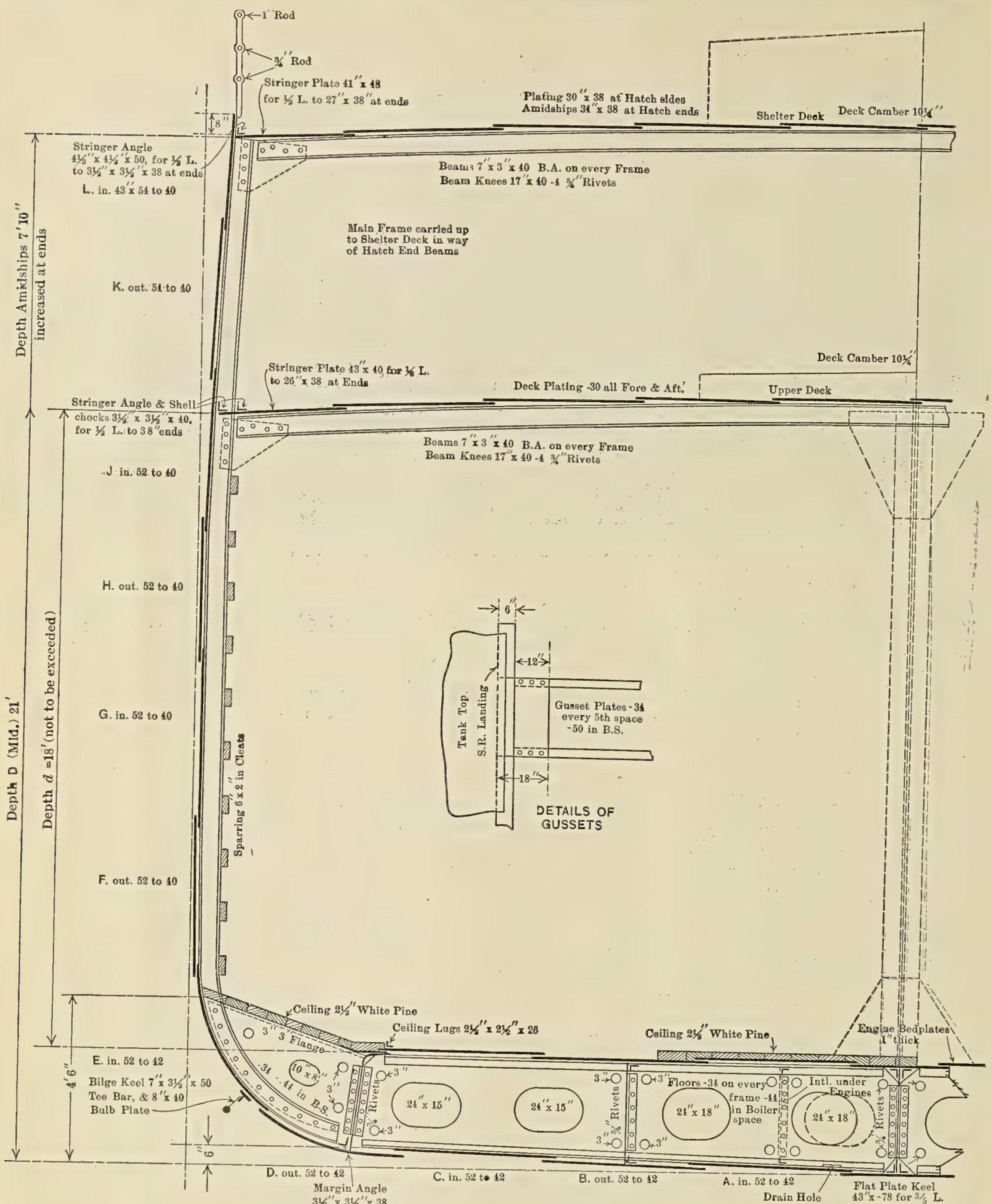


Fig. 2.—Midship Section

The vessels are divided into five watertight compartments, with a cross bunker forward of the boiler space. The forepeak bulkhead extends to the shelter deck and the others to the upper deck, the engine and boiler room bulkheads being extended to the shelter deck, forming 'tween deck bunker ends. There are two pocket bunkers on each side of the engine room, a cross bunker forward of the stokehold, and 'tween deck bunkers abreast of the engine and boiler room casings.

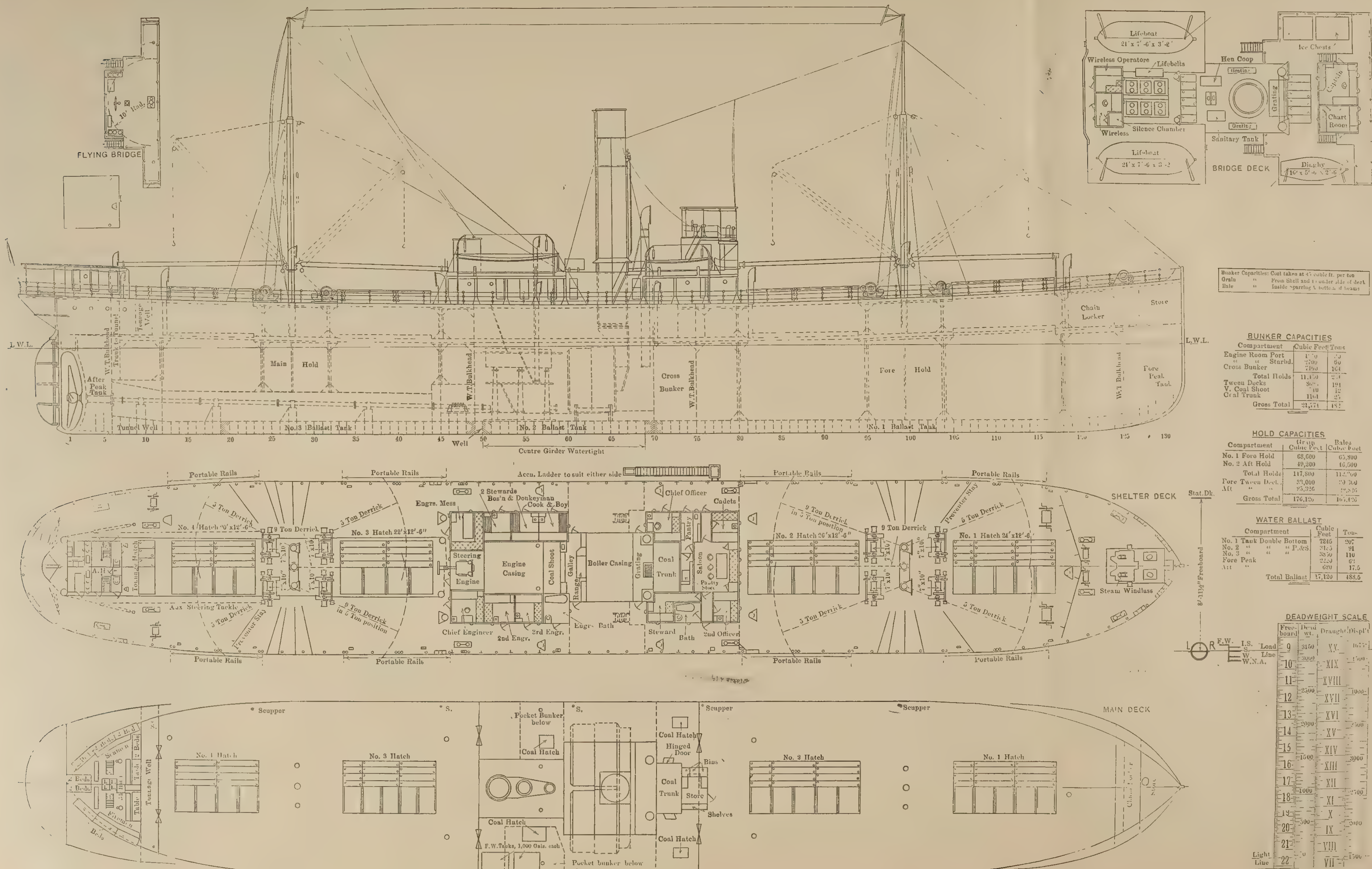
Two hatchways give access to each hold, those in No. 1 forehold being 24 feet by 12 feet 6 inches and 26 feet by 12 feet 6 inches, respectively, and those in No. 2 after hold 22 feet by 12 feet 6 inches and 20 feet by 12 feet 6 inches.

Accommodations for Officers and Crew

A chart house built of steel, situated on the bridge deck, is subdivided to provide a chart room and accommodation for the captain. A deck house is erected on the boat deck, and provides a wireless cabin and accommodations

(*Concluded on page 380.*)

BRITISH STANDARD CARGO STEAMSHIP OF 3,150 TONS DEADWEIGHT



Bunker Capacities: Coal taken at 45 cubic ft. per ton
Grain " From Shell and to under side of deck
Bale " Inside sparring & bottom of beams

BUNKER CAPACITIES

Compartment	Cubic Feet	Tons
Engine Room Port	[illegible]	[illegible]
" " Starbd.	2700	80
Cross Bunker	[illegible]	104
Total Holds	[illegible]	[illegible]
Tween Decks	[illegible]	191
V. Coal Shoot	[illegible]	12
Coal Trunk	1161	25
Gross Total	[illegible]	[illegible]

HOLD CAPACITIES

Compartment	Grain Cubic Feet	Bales Cubic Feet
No. 1 Fore Hold	68,600	65,800
No. 2 Aft Hold	49,200	46,500
Total Holds	117,800	112,300
Fore Tween Decks	33,000	30,300
Aft " "	25,326	22,826
Gross Total	176,126	165,426

WATER BALLAST

Compartment	Cubic Feet	Tons
No. 1 Tank Double Bottom	7245	207
No. 2 " " " P.&S.	3185	91
No. 3 " " "	3850	110
Fore Peak	2220	63
Aft "	620	17.5
Total Ballast	17,120	488.5

Fig. 3.—General Arrangement Plans, Capacity and Deadweight Scale of *Cervantes* Type of Vessel

Vessels Built in the United States in 1919

Shipyard	Number of Ships	Total Dead-weight Tonnage	Total Horse-power
Wm. G. Abbott Shipbuilding Company	5	......	......
Alabama Dry Dock & Shipbuilding Company	5	21,200	8,100
Albina Engine & Machine Works, Inc	8	29,600	11,200
Allen Shipbuilding Company	3	10,950	1,400
American Bridge Company	55	......	......
American Car & Foundry Company	6	2,976	600
American International Shipbuilding Corpn.	69	500,800	172,500
American Lumber Company	1	2,500	......
American Shipbuilding Company (Cleveland)	98	399,600	135,600
American Shipbuilding Co. (Brunswick, Ga.)	5	12,500	7,000
Ames Shipbuilding & Dry Dock Company	12	105,600	35,200
Atlantic Corporation	4	35,200	11,200
Atlantic, Gulf & Pacific Company	8	1,750	......
William H. Baldwin	2	253	......
Baltimore Dry Docks & Shipbuilding Co	15	85,425	29,500
Bangor Shipbuilding Corporation	1	1,500	......
Barbare Brothers	3	10,500	1,400
Bath Iron Works	4	4,800	96,800
Bayles Shipyard, Inc	7	22,400	8,800
Beaumont Shipbuilding & Dry Dock Co	5	17,500	7,000
Benicia Shipbuilding Corporation	3	10,500	......
A. Bentley & Sons Company	1	7,500	2,800
Bethlehem Shipbuilding Corporation, Ltd.:			
Fore River plant	40	113,152	549,040
Squantum plant	29	35,525	783,000
Moore plant	21	10,940	16,200
Harlan plant	6	37,800	12,150
Sparrows Point plant	11	103,000	29,900
Potrero Works	17	20,185	729,000
Alameda Works	10	111,200	29,200
Total	134	431,802	2,148,490
Bowker Ship Yard	2	1,452	......
A. C. Brown & Sons	1	......	......
Burger Boat Building Company	8	......	4,500
Carolina Ship Building Corporation	7	67,200	19,600
Chance Marine Construction Company	3	501	1,360
R. J. Chandler Shipbuilding Company	1	3,500	1,400
Chicago Bridge & Iron Works	8	4,000	......
Coast Shipbuilding Company	5	17,500	7,000
Coastwise Shipbuilding Company	3	7,500	......
Frances Cobb Shipbuilding Company	1	2,500	......
Columbia River Shipbuilding Corporation	16	166,400	43,600
Consolidated Shipbuilding Corporation	2	2,000	2,800
Continental Shipbuilding Corporation	1	1,500	......
Coos Bay Shipbuilding Company	7	15,500	1,400
Wm. Cramp & Sons Ship & Engine Bldg. Co.	22	52,155	541,000
H. E. Crook Company	2	5,000	......
Crosby Navigation Company	2	5,000	......
Crowell & Thurlow	10	18,800	......
Crowninshield Shipbuilding Company	5	......	4,250
Cumberland Shipbuilding Company	8	28,000	11,200
Dachel-Carter Shipbuilding Company	3	448	975
Oscar Daniels Company	5	47,500	14,000
Dantzler Shipbuilding & Dry Dock Co., Inc.	4	14,000	2,800
M. M. Davis & Sons, Inc	5	......	......
G. G. Deering Company	1	3,500	......
Dierks-Blodgett Shipbuilding Company	5	17,500	......
Doullut & Williams Shipbuilding Company	2	19,200	5,600
Downey Shipbuilding Corporation	9	70,200	22,500
The Dravo Contracting Company	28	21,380	1,500
Dubuque Boat & Iron Works	5	8,500	1,700
	5	......	800
Dunn & Elliott Company	2	3,900	......
J. F. Duthie & Company	10	88,000	28,000
East Coast Ship Company	2	2,200	......
Federal Shipbuilding Company	27	261,900	67,500
Feeney & Bremer Company	1	3,500	......
Ferguson Steel & Iron Company	21	12,200	9,000
Fougner Shipbuilding Company	1	3,500	1,400
The Foundation Company	51	72,600	40,200
Freeport Shipbuilding Company	2	7,000	2,800
Fry Flynn Company	2	3,600	......
Fulton Shipbuilding Company	5	18,500	4,200
Gibbs Gas Engine Company	2	......	......
George A. Gilchrist	1	3,500	1,400
Gildersleeve Ship Construction Company	2	7,000	1,400
Globe Shipbuilding Company	10	38,750	13,750
Grays Harbor Motorship Corporation	6	19,500	11,200
Great Lakes Engineering Works	40	167,600	57,000
Richard T. Green Company	1	2,500	......
Greenport Basin & Construction Company	9	10,113	650
Groton Iron Works (Noank)	2	7,000	......
Groton Iron Works	6	52,800	15,000
Hammond Lumber Company	5	17,500	2,800
Hampton Shipbuilding & Dry Dock Corpn.	2	7,000	......
Hanlon Dry Dock & Shipbuilding Company	2	10,700	3,600
Louis B. Harrison Shipyards, Inc	6	9,600	......
Heldenfels Brothers	2	7,000	......
Hodge Ship Company	1	3,500	1,400
Housatonic Shipbuilding Company	6	21,000	1,400
Hullfin Boat Company	1	40	28
International Shipbuilding & Marine Engineering Corporation	2	......	......
Jahncke Shipbuilding Corporation	4	14,000	5,600
John F. James & Son	2	281	300
Johnson Iron Works, Ltd.	12	1,670	7,554
Johnson Shipyards Corporation	4	13,000	1,400
Kelly-Spear Company	3	8,500	1,400
Kingston Shipbuilding Company	2	7,000	2,800
Kruse & Banks Shipbuilding Company	4	14,000	......
Kyle & Purdy, Inc.	6	2,550	5,100
Lake Torpedo Boat Company	8	......	......
Leatham & Smith Towing & Wrecking Co.	5	......	2,250
Fred T. Ley & Company, Inc	2	17,000	5,600
Liberty Shipbuilding Company	1	3,000	1,400
Lone Star Shipbuilding Company	5	17,500	5,200
Long Beach Shipbuilding Company	6	41,400	14,700
Los Angeles Shipbuilding & Dry Dock Co.	10	88,000	35,000
McAteer Ship Building Company	2	5,000	500
McBride & Law	2	7,000	2,800
J. N. McCammon	2	7,400	......
McDougall-Duluth Company	17	65,600	23,250
McEachern Ship Company	9	31,500	8,400
Machias Ship Construction Company	3	7,500	......
Manistee Shipbuilding Company	1	3,750	......
Manitowoc Ship Building Company	13	48,750	......
Maryland Shipbuilding Company	4	14,000	2,800
J. H. Mathis Company	1	......	......
Meacham & Babcock	10	35,000	5,600
Merchant Shipbuilding Corporation	28	248,400	81,500
Merrill-Stevens Shipbuilding Corporation	2	12,000	4,000
Midland Bridge Company	10	34,100	8,400
Missouri Bridge & Iron Company	2	7,000	......
Mobile Shipbuilding Company	7	27,500	9,950
Moore Shipbuilding Company	16	151,000	44,800
Morey & Thomas	3	10,500	2,800
J. W. Murdoch	2	7,000	1,400
Murnan Shipbuilding Company	2	7,000	......
Nashville Bridge Company	3	5,400	......
National Ship Building Company	10	50,000	14,500
National Shipbuilding Corporation	2	7,500	2,250
Newburgh Shipyards	7	61,754	19,600
Newcastle Shipbuilding Company	2	5,000	......
Newport News Shipbuilding & Dry Dock Co.	12	50,925	226,600
Newport Shipbuilding Company	3	1,500	1,800
New York Shipbuilding Corporation	16	65,050	299,850
Nilson & Kelez Shipbuilding Corporation	3	10,500	1,400
North Carolina Shipbuilidng Company	2	7,000	......
Northwest Engineering Works	15	2,945	10,000
Northwest Steel Company	18	158,400	47,400
Pacific American Fisheries	3	10,500	4,500
Pacific Coast Shipbuilding Company	3	28,200	9,600
Pacific Marine Construction Company	2	15,000	5,600
Peninsula Shipbuilding Company	4	16,000	6,000
Pensacola Shipbuilding Company	4	36,000	12,000
Percy & Small, Inc.	2	2,860	......
Providence Engineering Corporation	6	......	4,800
Puget Sound Bridge & Dredging Company	4	18,000	2,800
Pusey & Jones Company	15	107,200	32,250
Rolph Shipbuilding Company	3	10,500	......
Russell Shipbuilding Company	2	7,000	......
George D. Ryan & Son	7	1,785	225
Saginaw Shipbuilding Company	8	28,000	11,600
St. Helens Shipbuilding Company	3	10,500	1,400
St. John's River Shipyard Company	8	25,000	......
Sanderson & Porter	10	35,000	1,400
Sandy Point Shipbuilding Company	4	12,000	......
San Francisco Shipbuilding Company	1	2,500	2,800
Seaboard Transportation & Shipping Co.	2	400	400
Seaborn Shipyards	6	21,000	2,800
Seattle Construction & Drydock Company	6	45,000	14,400
Seattle North Pacific Shipbuilding Company	10	94,000	28,000
L. H. Shattuck, Inc	14	49,000	11,800
The Ship Construction & Trading Co., Inc.	3	10,000	1,400
Skinner & Eddy Corporation	33	326,000	90,500
Sloan Shipyards Corporation	8	28,000	7,000
Grant Smith-Porter Ship Company	25	87,500	25,200
Henry Smith & Sons Company	2	7,000	......
Sommarstrom Shipbuilding Company	7	24,500	8,400
Southern Dry Dock & Shipbuilding Company	5	17,500	......
Southand Steamship Company	7	......	6,300
Southwestern Shipbuilding Company	9	79,200	25,200
Standard Shipbuilding Corporation	10	74,000	25,000
G. M. Standifer Construction Corporation	22	121,900	16,800
Staten Island Shipbuilding Company	11	3,500	17,600
Stockton Yard, Inc	2	4,000	......
Story's Ship Yard	5	1,385	625
Submarine Boat Corporation	95	508,250	142,500
John W. Sullivan	1	......	......
Sun Shipbuilding Company	10	112,349	38,000
Supple-Ballin Shipbuilding Corporation	6	25,500	9,300
Tacoma Shipbuilding Company	6	21,000	2,800
Tampa Dock Company	3	10,500	2,800
Tampa Shipbuilding & Engineering Company	2	7,000	......
Tank-Ship Building Corporation	2	3,500	1,000
C. H. Tenney & Company	2	7,000	......
Terry Shipbuilding Corporation	6	21,000	8,400
Texas Steamship Company	14	44,489	13,500
Thames Towboat Company	1	197	500
Todd Dry Dock & Construction Corporation	11	84,700	28,100
Todd Shipyards Corporation	16	73,000	31,400
Toledo Shipbuilding Company	12	46,950	17,100
Traylor Shipbuilding Corporation	3	10,500	4,200
E. James Tull	1	470	......
Union Construction Company	3	28,650	8,400
United States Maritime Corporation	3	10,500	4,200
Universal Shipbuilding Company	3	10,500	5,200
Vinyard Shipbuilding Company	1	......	......
Virginia Shipbuilding Corporation	5	17,000	14,000
Western Pipe & Steel Company	10	88,000	25,000
Whitehaven Shipbuilding Company	2	5,000	......
Whitney Brothers Company	10	4,234	9,500
Wilson Shipbuilding Company	4	14,000	1,400
Wright Shipbuilding Company	4	14,000	1,400
York River Shipbuilding Company	2	7,000	......

Vessels Building in American Shipyards

OWNER	TYPE	DEADWEIGHT TONNAGE*	HORSE-POWER	NO. OF VESSELS	TOTAL DEAD-WEIGHT TONNAGE
Alabama Dry Dock & Shipbuilding Company, Mobile, Ala.					
Panama Railroad	Coal Barges	7,500	......	2	15,000
American Bridge Company, Pittsburgh, Pa.					
United States Government	Barges	......	......	8	......
Standard Oil Company of Louisiana	Oil Barges	......	......	7	......
Standard Coal Company of California	Fuel Barges	......	......	2	......
Sinclair Navigation Company, New York	Oil Barges	......	......	4	......
Mexican Petroleum Corporation, Tampico, Mexico	Oil Barges	......	......	4	......
Missouri Portland Cement Company	Sand Barges	......	......	3	......
American Car & Foundry Company, Wilmington, Del.					
United States Government	15-Car Float	......	......	1	......
United States Government	10-Car Float	......	......	3	......
Builder	4-Masted Schooners (length 210 ft.)	......	......	3	......
American International Shipbuilding Corporation, Hog Island, Pa.					
United States Shipping Board	Freighters	7,825	2,500	41	340,825
United States Army	Transports	9,300	6,000	10	93,000
American Shipbuilding Company, Cleveland Ohio					
Pittsburgh Steel Company	Freighters	4,500	......	4	18,000
United States Shipping Board	Cargo	4,200	1,500	9	37,800
Ames Shipbuilding & Drydock Company, Portland, Ore.					
United States Shipping Board	Cargo	8,800	2,800	3	26,400
Atlantic Coast Company, Thomaston, Maine					
Atlantic Coast Company, Boston, Mass.	4-Masted Schooners	2,000	......	6	12,000
Atlantic Corporation, Portsmouth, N. H.					
United States Shipping Board	Cargo	8,800	2,800	6	52,800
Atlantic, Gulf & Pacific Company, Brooklyn, N. Y.					
United States Navy	Coal Barges	250	......	7	1,750
United States Shipping Board	Dry Dock Sections	2,000	......	14	28,000
Baltimore Dry Dock & Ship Building Company, Baltimore, Md.					
United States Shipping Board	Tankers	10,000	2,700	5	50,000
United States Shipping Board	Tankers	6,000	1,800	3	18,000
Builder	Freighters	......	......	2	......
Bath Iron Works, Ltd., Bath, Maine					
Crowell & Thurlow, Boston, Mass.	Cargo	13,000	......	1	13,000
Crowell & Thurlow, Boston, Mass.	Cargo	7,000	2,200	1	7,000
United States Navy	Destroyers	1,200	26,200	4	4,800
Bayles Shipyards, Inc., Port Jefferson, N. Y.					
United States Shipping Board	Cargo	5,000	1,600	3	15,000
Beaumont Ship Building & Dry Dock Company, Beaumont, Texas					
......	Schooners	2,000	......	2	4,000
United States Shipping Board	Barge	2,000	......	1	2,000
A. Bentley & Sons Company, Jacksonville, Fla.					
United States Shipping Board	Concrete Tanker	7,500	2,800	2	15,000
Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa.					
Union Plant, San Francisco, Cal. (Protrero Works)					
United States Navy	Destroyers	1,185	27,000	2	2,370
United States Navy	Destroyers	1,225	27,000	39	47,775
United States Navy	Submarines	854	1,200	12	10,248
United States Shipping Board	Cargo	11,800	3,000	3	35,400
Pan-American Petroleum Company, Los Angeles, Cal.	Tankers	10,200	2,700	3	30,600
Standard Oil Company of California, San Francisco, Cal.	Tanker	12,800	3,000	1	12,800
Union Plant, San Francisco, Cal. (Alameda Works)					
United States Shipping Board	Tankers	10,100	2,800	14	141,400
Standard Transportation Company, New York	Tanker	10,100	2,800	1	10,100
Sandard Oil Company of Caifornia, San Francisco, Cal.	Tanker	10,200	2,800	1	10,200
General Petroleum Company, San Francisco, Cal.	Tanker	10,200	2,800	1	10,200
Fore River Plant, Quincy, Mass.					
United States Navy	Battle Cruiser	34,800	180,000	1	34,800
United States Navy	Scout Cruisers	7,100	90,000	2	14,200
United States Navy	Battleship	43,000	65,000	1	43,000
United States Navy	Submarines	1,106.2	4,000	3	3,318.6
United States Navy	Submarines	854	1,200	13	11,102
United States Navy	Submarines	860	1,200	6	5,160
Ore Steamship Corporation, New York	Ore Carrier	11,500	2,500	1	11,500
Standard Transportation Company, New York	Tankers	12,620	3,200	4	50,480
Atlantic, Gulf & West Indies Steamship Lines, New York	Tanker	12,620	3,200	1	12,620
Sinclair Navigation Company, New York	Tankers	10,600	2,600	2	21,200
United States Shipping Board	Tankers	9,100	......	2	18,200
Fore River Plant, Quincy, Mass.					
United States Navy	Destroyers	1,225	27,000	5	6,125
Moore Plant, Elizabeth, N. J.					
United States Shipping Board	Cargo	5,100	1,450	2	10,200
Standard Oil Company of New York	Oil Barges	690	......	3	2,070
Harlem Plant, Wilmington, Del.					
United States Shipping Board	Cargo	7,400	2,500	3	22,200
United States Shipping Board	Cargo	5,100	1,450	2	10,200
United States Shipping Board	Tankers	7,500	2,600	3	22,500
Sinclair Navigation Company, New York	Tankers	10,600	2,600	2	21,200
Sinclair Navigation Company, New York	Tankers	6,900	2,600	2	13,800
British Interests	Tankers	8,500	......	2	17,000
British Interests	Tankers	7,300	......	2	14,600
Sparrows Point Plant, Sparrows Point, Md.					
United States Shipping Board	Passenger	10,100	12,000	8	80,800
United States Shipping Board	Tankers	10,100	2,800	2	20,200
Standard Transportation Company, New York	Tankers	10,100	2,800	3	30,300
Vacuum Oil Company, New York	Tanker	10,200	2,800	1	10,200
Atlantic, Gulf & West Indies Steamship Lines, New York	Tankers	12,620	3,200	3	37,860
Ore Steamship Corporation, New York	Ore Carrier	20,000	......	1	20,000
International Petroleum Company	Ore Carrier	20,000	......	1	20,000
A. C. Brown & Sons, Tottenville, N. Y.					
United States Shipping Board	Harbor Tugs (length 100 ft.)	......	......	4	......
Carolina Ship Building Corporation, Wilmington, Del.					
United States Shipping Board	Cargo	9,600	2.800	12	115,200
Chance Marine Construction Company, Annapolis, Md.					
United States Shipping Board	Tugs (length 100 ft.)	......	......	3	......
R. J. Chandler Shipbuilding Company, Los Angeles, Cal.					
San Diego & Coronado Ferry Company	Ferryboat	......	......	1	......
Los Angeles Shipbuilding Company	Drydock	10,000	......	..	10,000
Chicago Shipbuilding Company, Chicago, Ill.					
United States Shipping Board	Freighters	3,500	......	40	140,000

* Naval construction tonnage is given in terms of displacement.

OWNER	TYPE	DEADWEIGHT TONNAGE*	HORSE-POWER	NO. OF VESSELS	TOTAL DEAD-WEIGHT TONNAGE
Chickasaw Shipbuilding Company, Mobile, Ala.					
Builder	Freighters	6,869	......	6	41,214
United States Steel Corporation, New York	Freighters	6,000	......	10	60,000
	Freighters	9,600	......	4	38,400
Clayton Ship & Boat Building Corporation, Clayton, N. Y.					
United States Navy	Deep-Hold Barges	......	......	15	......
United States Navy	Tugs (length 88 ft.)	......	......	3	......
Clooney Construction & Towing Company, Westlake, La.					
	Barges	588	......	5	2,940
	Barges	60	......	2	120
	Dredge Hull	......	......	1	......
	Barges	500	......	3	1,500
	River Barges	......	......	6	......
Coastwise Shipbuilding Company, Baltimore, Md.					
United States Shipping Board	Schooner Barge	2,500	......	3	7,500
Northern Transportation Company	Schooners	2,000	......	4	8,000
Consolidated Shipbuilding Corporation, Morris Heights, N. Y.					
United States Shipping Board	Tugs (length 100 ft.)	......	......	5	......
United States Government	Lightship	......	......	1	......
	230-Foot Steam Yacht		......	1	......
William Cramp & Sons Ship and Engine Building Company, Philadelphia, Pa.					
United States Navy	Tankers	10,000	2,800	2	20,000
United States Shipping Board	Freighters	9,400	3,400	2	18,800
	Car Ferry	2,300	......	1	2,300
	Passenger and Freight (350 ft.)	......	......	1	......
United States Navy	Destroyers	1,215	28,000	17	20,655
United States Navy	Scout Cruisers	7,100	90,000	5	35,500
Crosby Navigaion Company, Bath, Maine					
	4-Masted Schooner (length 180 ft.)	......	......	1	......
Cumberland Shipbuilding Company, Portland, Maine					
	4-Masted Schooner	1,800	......	1	......
Oscar Daniels Company, Tampa, Fla.					
Standard Oil Company of New Jersey	Tankers	11,900	2,800	2	23,800
United States Shipping Board	Freighters	9,500	2,800	7	66,500
Defoe Shipbuilding Company, Bay City, Mich.					
United States Navy	Mine Planters (length 100 ft.)	......	350	8	......
Delaware Shipbuilding and Repair Company, Camden, N. J.					
	Seagoing Barge	2,500	......	1	2,500
Denton Shore Lumber Company, Tampa, Fla.					
	2-Masted Schooner Barges	500	......	2	......
Dierks-Blodgett Shipbuilding Company, Pascagoula, Miss.					
United States Shipping Board	Freighters	3,500	......	3	10,500
United States Shipping Board	Combination Steamers	8,000	......	4	32,000
Doullut & Williams Shipbuilding Company, New Orleans, La.					
United States Shipping Board	Cargo	9,600	2,800	8	76,800
Downey Shipbuilding Corporation, Arlington, Staten Island, N. Y.					
Southern Pacific Company, New York	Freighters	5,000	......	3	15,000
Coastwise Transportation Company, Boston, Mass.	Passenger and Freight	......	......	1	......
The Dravo Contracting Company, Pittsburgh, Pa.					
United States Shipping Board	Barges	3,000	......	2	6,000
United States Government	Barges	2,500	......	12	30,000
United States Government	Tugs	300	......	3	900
Dravo Contracting Company	Derrick Barges	......	......	2	......
Keystone Sand & Supply Company	Barges	500	......	4	2,000
Dubuque Boat & Boiler Works, Dubuque, Ia.					
	Steel Barges (length 300 ft.)	......	......	7	......
United States Government	Barges	......	......	1	......
	Ferryboat	......	......	1	......
Dunn & Elliott Company, Thomaston, Maine					
	4-Masted Schooner (length 209 ft.)	......	......	1	......
J. F. Duthie & Company, Seattle, Wash.					
Coastwise Steamship & Barge Company, Seattle, Wash.	Freighter	2,350	......	1	2,350
United States Shipping Board	Cargo	8,800	2,800	3	26,400
East Coast Ship Company, Somerville, Mass.					
	Schooner	1,250	......	1	......
Elliot Bay Shipbuilding Company, Seattle, Wash.					
Weiss Packing Company, Seattle, Wash.	Wooden Motorships	3,000	1,000	5	15,000
	Motorships	3,000	1,000	4	12,000
	Wooden Freighters	3,500	......	5	17,500
Fabricated Ship Corporation, Milwaukee, Wis.					
Coast Artillery Corps, United States Army	Mine Planters	1,000	900	9	9,000
Transportation Service, War Department	River Steamers	600	700	4	2,400
Federal Shipbuilding Company, Kearney, N. J.					
United States Steel Corporation, New York	Freighters	9,700	2,500	3	29,100
United States Steel Corporation, New York	Freighters	9,650	2,500	10	96,500
Standard Oil Company of New Jersey	Tankers	15,100	3,500	5	75,500
Freeport Sulphur Company	Tankers	6,600	1,700	2	13,200
Ferguson Steel & Iron Company, Buffalo, N. Y.					
	Seagoing Tug	......	......	1	......
	Tug (length 75 ft.)	......	......	1	......
	Refrigerator Ships	......	......	2	......
Foundation Company, New Orleans, La.					
Republic of France	Cargo	4,300	1,400	5	21,500
Frye, Flynn Company, Harrington, Maine					
	4-Masted Schooners (length 185 ft.)	......	......	2	......
Gibbs Gas Engine Company, Jacksonville, Fla.					
United States Shipping Board	Harbor Tugs (length 100 ft.)	......	......	4	......
Globe Shipbuilding Company, Superior, Wis.					
United States Shipping Board	Freighters	4,050	1,500	4	16,200
Grays Harbor Motorship Corporation, Aberdeen, Wash.					
Builder	Barkentines	2,500	......	5	12,500
Builder	Barges	700	......	2	1,400
Great Lakes Engineering Works, Detroit, Mich.					
United States Shipping Board	Cargo	4,050	1,500	7	28,350
	Tugs (length 88 ft.)	......	350	2	......
	Motorboats	......	4,300	21	......
Groton Iron Works, Groton, Conn.					
United States Shipping Board	Cargo	9,400	2,800	3	28,200
United States Shipping Board	Cargo	8,800	2,500	6	52,800
Groton Iron Works, Groton, Conn.					
United States Shipping Board	Wooden Freighters	3,500	......	3	10,500
Gulf Shipbuilding Company, Millville, Fla.					
Builder	Motor Schooner	2,200	400	1	2,200

OWNER	TYPE	DEADWEIGHT TONNAGE*	HORSE-POWER	NO. OF VESSELS	TOTAL DEAD-WEIGHT TONNAGE
Hanlon Dry Dock & Shipbuilding Company, East Oakland, Cal.					
United States Shipping Board	Cargo	5,350	1,800	7	37,450
Heldenfels Brothers, Rockport, Texas					
United States Shipping Board	Barge	4,000	......	2	8,000
Herreshoff Manufacturing Company, Inc., Bristol, R. I.					
	Steel Schooner Yacht (length 109 ft.)	......	100	1	......
	Steam Yacht (length 140 ft.)	......	1,500	1	......
	Motor Yacht (length 82 ft.)	......	250	1	......
	Motor Yacht (length 66 ft.)	......	400	1	......
	Motor Yacht (length 58 ft.)	......	60	1	......
Hollywood Shipbuilding Company, Oakland, Cal.					
United States Shipping Board	Cargo	8,800	2,800	4	35,200
Howard Ship Yards & Dock Company, Jeffersonville, Ind.					
Great Southern Refining Company	Oil Barges	......	......	3	......
Engineering Corps, United States Army	Tunnel Tow Boats	......	......	3	......
Engineering Corps, United States Army	Maneuver Boat	......	......	1	......
International Shipbuilding Company, Pascagoula, Miss.					
J. A. Bondi	Freighters	4,200	......	8	33,600
	Barkentines	3,600	......	2	7,200
Jahncke Shipbuilding Corporation, New Orleans, La.					
	Standard Wooden Freighters	3,500	......	12	42,000
	Drydock	10,000	......	1	10,000
Job Shipyard Corporation, Machias, Maine					
Builder	Schooners	1,350	......	2	2,700
Builder	Schooner	2,500	......	1	2,500
Builder	Barge (length 118 ft.)	......	......	1	......
United States Shipping Board	Harbor Tugs	......	......	2	......
The Johnson Iron Works, Ltd., New Orleans, La.					
Cortez Oil Corporation	Barge (length 100 ft.)	......	......	1	......
United States Shipping Board	Harbor Tugs (length 100 ft.)	......	800	2	......
Kingston Shipbuilding Company, Kingston, N. Y.					
United States Shipping Board	Floating Drydock	16,000	......	1	16,000
Kyle & Purdy Incorporated, City Island, N. Y.					
United States Shipping Board	Tugs (length 150 ft.)	......	......	4	......
East Coast Fisheries Company	Trawlers (length 150 ft.)	......	......	2	......
M. Fleischmann	Yacht (length 145 ft.)	......	......	1	......
Lake and Ocean Shipbuilding Company, Cleveland, Ohio					
Hannevig, Inc., New York	Motorships	3,000	1,000	3	9,000
	Freighter	3,500	......	1	3,500
The Lake Torpedo Boat Company, Bridgeport, Conn.					
United States Navy	Submarines	......	......	8	......
George Lawley & Son Corporation, Neponset, Mass.					
United States Navy	Torpedo Testing Barge	......	......	1	......
Edgar Palmer	3-Masted Auxiliary Schooner	......	......	1	......
R. T. Crane, Jr.	Steel Motor Yacht (length 108 ft.)	......	......	1	......
J. H. Walker	Wood Motor Yacht (length 115 ft.)	......	......	1	......
Leathem & Smith Towing & Wrecking Company, Sturgeon Bay, Wis.					
United States Shipping Board	Harbor Tugs (30 tons, gross)	......	450	4	120
	Harbor Tugs (30 tons, gross)	......	450	8	240
Le Parmentier Shipbuilding Corporation, New York City					
Republic of France	Cargo	4,240	1,400	2	8,480
Fred T. Ley Company, Mobile, Ala.					
United States Shipping Board	Concrete Tankers	7,500	2,800	2	15,000
United States Shipping Board	Concrete Freighters	7,500	2,800	2	15,000
Liberty Shipbuilding Company, Wilmington, N. C.					
United States Shipping Board	Concrete Tankers	3,500	1,400	2	7,000
Lone Star Shipbuilding Company, Beaumont, Texas					
French Interests	Freighters	4,200	......	6	25,200
Long Beach Shipbuilding Company, Long Beach, Cal.					
United States Shipping Board	Cargo	8,800	2,800	4	35,200
	Cargo	1,600	......	1	1,600
	Cargo	1,700	......	1	1,700
California & Mexico Steamship Company	Passenger	......	......	2	......
Standard Oil Company, New York	Tanker	950	......	1	950
Los Angeles Shipbuilding & Dry Dock Company, San Pedro, Cal.					
United States Shipping Board	Freighters	8,800	3,500	12	105,600
United States Shipping Board	Freighters	11,300	3,500	5	56,500
McAteer Ship Building Company, Seattle, Wash					
Quartermaster Department, United States Army	Supply	1,000	......	1	1,000
McDougall-Duluth Company, Duluth, Minn.					
United States Shipping Board	Cargo	4,150	1,500	7	29,050
Roberts Steamship Company	Cargo	3,600	1,250	5	18,000
Builders	Freighters	2,338	......	4	9,352
Barnes Steamship Company	Freighter	2,338	......	1	2,338
MacDonald Engineering Company, Arkansas Pass, Texas					
France and Canada Oil Transport Company, New York	Concrete Tankers	2,000	640	2	4,000
Manistee Shipbuilding Company, Manistee, Mich					
Northern Transportation Company, Wilmington, Del.	Barges	3,750	......	2	7,500
	Schooner Barge	4,000	......	1	4,000
Manitowoc Shipbuilding Company, Manitowoc, Wis.					
United States Shipping Board	Freighters	4,050	1,500	6	24,300
Atlantic Fruit Company, New York	Freighters	1,900	......	2	3,800
John H. Mathis, Camden, N. J.					
United States Shipping Board	Harbor Tugs (length 100 ft.)	......	......	2	......
J. E. Matton, P. O. Waterford, N. Y.					
E. G. Murray Lighterage & Transport Company	Grain Barges	650	......	6	3,900
	Grain Barge	650	......	1	650
Lake Champlain Transportation Company	Grain Barges	650	......	2	1,300
Champlain Boat Company	Grain Barges	650	......	2	1,300
Builder	Grain Barges	650	......	4	2,600
P. J. Matton, Watervliet, N. Y.					
	Canal Barges	650	......	2	1,300
Capt. George King	Canal Barges	800	......	2	1,600
Homer Bond	Canal Barge	800	......	1	800
Theodore Miller	Canal Barge	750	......	1	750
Frank Waslrod	Reinforced Barges	......	......	2	......
Merchant Shipbuilding Corporation, New York					
Chester Yard, Chester, Pa.					
Shawmut Steamship Company, Boston, Mass	Freighters	10,000	......	2	20,000
Union Oil Company of California	Tankers	10,000	......	2	20,000
Cochrane-Harper Company, Boston, Mass	Tankers	10,000	......	2	20,000
American-Hawaiian Company, New York	Motorships	11,000	......	2	22,000
United States Shipping Board	Freighters	9,000	3,000	10	90,000
Union Oil Company of Delaware	Tankers	10,500	......	2	21,000

OWNER	TYPE	DEADWEIGHT TONNAGE*	HORSE-POWER	NO. OF VESSELS	TOTAL DEAD-WEIGHT TONNAGE
Harriman Yard, Bristol, Pa.					
Atlantic, Gulf & West Indies Steamship Lines, New York	Tankers	12,500	......	6	75,000
United States Shipping Board	Freighters	8,800	3,000	18	158,400
Merrill-Stevens Shipbuilding Corporation, Jacksonville, Fla.					
United States Shipping Board	Freighters	6,000	2,000	3	18,000
......	Freighter	6,000	2,000	1	2,000
Mobile Shipbuilding Company, Mobile, Ala.					
United States Shipping Board	Freighters	5,000	1,600	10	50,000
Moore Shipbuilding Company, Oakland, Cal.					
United States Shipping Board	Refrigerator	9,400	2,800	1	9,400
United States Shipping Board	Freighters	9,400	2,800	7	65,800
United States Shipping Board	Tankers	10,000	2,800	7	70,000
Matson Navigation Company, San Francisco, Cal	Freighters	14,000	6,000	2	28,000
Standard Oil Compauy of New Jersey	Tankers	7,000	......	3	21,000
Standard Oil Company of California	Tanker	900	......	1	900
Vacuum Oil Company, New York	Tanker	10,000	......	1	10,000
Narragansett Ship Building Company, Tiverton, R. I.					
......	Drydock Pontoons	1,500	......	8	12,000
United States Government	Drydock	20,000	......	1	20,000
Nashville Bridge Company, Nashville, Tenn.					
United States Shipping Board	Barge	1,800	......	2	3,600
National Ship Building Company, New York					
......	Wooden Cargo Ship	5,000	1,450	4	20,000
......	Oil Barge	......	......	1	......
National Shipbuilding Corporation, New Orleans, La.					
......	Oil Barges	1,200	......	7	8,400
......	Fruit Barges	500	200	4	2,000
Newburgh Shipyards, Newburgh, N. Y.					
United States Shipping Board	Freighters	8,800	......	2	17,600
Union Sulphur Company, New York	Sulphur Carriers	7,000	......	2	14,000
Aryamel Fruit Company, New Orleans	Freighters	2,500	......	3	7,500
Newcastle Shipbilding Company, Damariscotte, Maine					
......	5-Masted Schooner	2,600	......	1	2,600
......	Schooners	1,000	......	2	2,000
Newport News Shipbuilding & Dry Dock Company, Newport News, Va.					
United States Navy	Battleship	32,500	65,000	1	32,500
United States Navy	Destroyers	1,225	28,000	4	4,900
Standard Oil Company of New Jersey	Tankers	20,500	3,800	2	41,000
Atlantic, Gulf & West Indies Steamship Lines, New York	Tankers	7,000	......	2	14,000
United States Shipping Board	Passenger and Cargo	13,500	12,000	2	27,000
United States Shipping Board	Tankers	11,375	2,800	5	56,875
Newport Shipbuilding Company, New Bern, N. S.					
......	River Steamers	700	600	6	4,200
New York Shipbuilding Corporation, Camden, N. J.					
United States Shipping Board	Passenger and Cargo	13,500	12,000	9	121,500
United States Shipping Board	Passenger and Cargo	11,000	6,000	7	77,000
W. R. Grace & Company, New York	Tanker	9,340	......	1	9,340
Standard Transportation Company, New York	Tanker	12,600	......	3	37,800
United States Navy	Battle Cruisers	43,500	180,000	1	43,500
United States Navy	Battleships	32,500	60,000	2	65,000
United States Navy	Destroyers	1,200	28,000	22	26,400
Northwest Engineering Works, Green Bay, Wis.					
......	Tugs	176	709	2	352
......	Tugs	450	1,000	5	2,250
United States Shipping Board	Tugs (length 150 ft.)	......	800	5	......
Norway Pacific Construction & Dry Dock Company, Everett, Wash.					
United States Army	Transport	16,000	5,000	1	16,000
Coast Guard Service	Service Cutters	1,600	2,600	5	8,000
Pacific-American Fisheries Company, South Bellingham, Wash.					
Builder	Wooden Freighter	3,500	1,500	3	10,500
Pacific Coast Shipbuilding Company, San Francisco, Cal.					
United States Shipping Board	Cargo	9,400	3,200	7	65,800
......	Freighters	6,000	......	2	12,000
Pacific Marine & Construction Company, San Diego, Cal.					
United States Shipping Board	Concrete Tankers	7,500	2,800	2	15,000
Peninsula Shipbuilding Company, Muskegon, Mich.					
United States Shipping Board	Sailing Vessels	4,000	......	2	8,000
Peninsula Shipbuilding Company, Portland, Ore.					
......	6-Masted Schooners	4,000	......	2	8,000
Pensacola Shipbuilding Company, Pensacola, Fla.					
United States Shipping Board	Cargo	9,000	3,000	6	54,000
J. H. Price Shipbuilding Company, Seattle, Wash.					
Christoffer Hannevig, New York	Motorships	3,000	......	2	6,000
Providence Engineering Corporation, Providence, R. I.					
United States Shipping Board	Ocean Tugs (length 150 ft.)	......	800	4	......
Pusey & Jones Company, Wilmington, Del.					
United States Shipping Board	Cargo	4,300	1,650	4	17,200
......	Freighters	12,500	3,000	6	75,000
Anglo-Saxon Company, London	Tankers	8,500	......	4	34,000
Shell Transport Company	Tankers	8,500	......	4	34,000
French Interests	Tankers	8,500	......	3	25,500
Eastern Steamship Company, Boston, Mass	Freighter	2,750	......	1	2,750
Rolph Shipbuilding Company, Humboldt Bay, Cal.					
United States Shipping Board	Cargo	3,500	......	2	7,000
George D. Ryan & Son, Oshkosh, Wis.					
......	Coal Barge	350	......	1	......
Saginaw Shipbuiding Company, Saginaw, Mich.					
United States Shipping Board	Freighters	4,050	1,400	6	24,300
San Francisco Shipbuilding Company, Oakland Bay, Cal.					
United States Shipping Board	Concrete Tankers	7,500	2,800	2	15,000
Schaw-Batcher Company, San Francisco, Cal.					
Union Oil Company of California	Tankers	12,000	......	2	24,000
Seaboard Transportation & Shipping Company, Galveston, Texas					
Builder	Tank Barge (capacity 25,000 barrels)	......	......	1	......
Builder	Tank Barge (capacity 18,000 barrels)	......	......	1	......
Seattle Construction & Dry Dock Company, Seattle, Wash.					
United States Shipping Board	Cargo	7,500	2,400	2	15,000
Seattle North Pacific Shipbuilding Company, Seattle, Wash.					
United States Shipping Board	Cargo	9,400	2,800	1	9,400
Skinner & Eddy Corporation, Seattle, Wash.					
Builder	Freighters	7,350	......	4	29,400

OWNER	TYPE	DEADWEIGHT TONNAGE*	HORSE-POWER	NO. OF VESSELS	TOTAL DEAD-WEIGHT TONNAGE
Southwestern Shipbuilding Company, Los Angeles, Cal.					
United States Shipping Board	Cargo	8,800	2,800	8	70,400
Builder	Freighter	2,800	......	1	2,800
Standard Shipbuilding Company, Shooter's Island, S. I., N. Y.					
Cuyamel Fruit Company, New Orleans, La	Fruit and Passenger (length 235 ft.)	......	......	2	......
Eagle Oil Transport Company, London	Tanker	8,400	......	4	33,600
United States Shipping Board	Freighters	7,400	2,500	4	29,600
G. M. Standifer Construction Corporation, Portland, Ore.					
Standarl Oil Company of New Jersey	Tankers	......	......	3	......
Green Star Steamship Corporation, New York	Cargo	9,000	......	5	45,000
United States Shipping Board	Cargo	9,400	2,800	2	18,800
Staten Island Shipbuilding Company, Port Richmond, S. I., N. Y.					
Tidewater Oil Company	Tanker	2,000	750	1	2,000
Galena Navigation Company	Tanker	4,000	......	1	4,000
American Sugar Refining Company of New Jersey	Molasses Tanker	6,300	......	2	12,600
Standard Oil Company of New York	Oil Barges	......	......	6	......
United States Navy	Tugs	......	1,800	6	......
Stockton Yard, Inc., Stockton Springs, Maine					
Builder	4-Masted Schooner	2,000	......	2	4,000
Submarine Boat Corporation, Newark, N. J.					
International Products Company	Refrigerators	1,400	......	2	2,800
Builder	Freighters	5,350	1,500	75	401,250
Sun Shipbuilding Company, Cheser, Pa.					
United States Shipping Board	Cargo	10,200	2,800	2	20,400
Gulf Refining Company, Pittsburgh, Pa	Tankers	10,600	......	2	21,200
Sun Company, Philadelphia, Pa	Tanker	10,600	......	1	10,600
Atlantic, Gulf & West Indies Steamship Lines, New York	Tankers	10,600	......	2	42,400
Atlantic, Gulf & West Indies Steamship Lines, New York	Tankers	12,000	......	4	48,000
Sinclair Navigation Company, New York	Tankers	10,600	......	2	21,200
Standard Oil Company of New York	Tankers	10,600	......	2	21,200
Pan-American Petroleum Transport Co., Los Angeles, Cal.	Tankers	10,600	......	2	21,200
Rotterdam Lloyd Steamship Company	Freighter	10,600	......	1	10,600
French Interests	Tanker	8,000	......	1	8,000
Union Oil Company of California	Tankers	12,500	......	2	25,000
Tank-Ship Building Company, Newburgh, N. Y.					
United States Navy	Oil Barges	500	150	5	2,500
Southern Oil & Transportation Corporation	Oil Barges	1,800	......	2	3,600
Terry Shipbuilding Corporation, Port Wentworth, Savannah, Ga.					
United States Shipping Board	Tanker	7,500	2,800	5	37,500
The Texas Steamship Corporation, Bath, Maine					
United States Shipping Board	Tankers	9,370	3,000	4	37,480
United States Shipping Board	Motor Tanker	4,400	......	1	4,400
Texas Company	Tankers	10,000	......	4	40,000
Todd Shipyards Corporation, New York, N. Y.					
United States Shipping Board	Freighters	7,500	2,800	12	90,000
Sincalir Navigation Company	Oil Barge	1,450	850	1	1,450
Donald Steamship Company	Fruit Carrier	1,500	1,000	1	1,500
United States Navy	Destroyer	1,125	28,000	1	1,125
United States Navy	Scout Cruisers	7,100	90,000	3	21,300
Toledo Shipbuilding Company, Toledo, Ohio					
United States Shipping Board	Cargo	4,050	1,500	4	16,200
E. James Tull, Pocomoke City, Md.					
......	3-Masted Schooner	470	......	1	470
......	Auxiliary Schooner	......	80	1	......
Union Construction Company, Oakland, Cal.					
United States Shipping Board	Tanker	2,000	......	1	2,000
United States Shipping Board	Cargo	9,550	2,800	8	76,400
Union Shipbuilding Company, Baltimore, Md.					
Aluminum Company of America	Freighters	4,600	......	2	9,200
Gulf Refining Company, Pittsburgh, Pa	Tankers	9,500	......	2	19,000
Builder	Freighters	9,600	......	2	19,200
United States Shipbuilding Corporation, Portland, Maine					
......	Wooden Freighters	2,700	......	2	5,400
......	Fabricated Ships	6,000	......	2	12,000
......	Auxiliary Schooner	1,500	......	1	1,500
United States Steel Corporation, Mobile, Ala.					
......	Freighters	3,300	1,250	2	6,600
Universal Shipbuilding Company, Sturgeon Bay, Wis.					
United States Shipping Board	Cargo	2,500	......	3	7,500
United States Shipping Board	Motorships	3,000	......	2	6,000
Virginia Shipbuilding Corporation, Alexandria, Va.					
United States Shipping Board	Freighters	9,400	2,800	7	65,800
Charles Ward Engineering Works, Charleston, W. Va.					
United States Government	Tunnel Towboats (length 200 ft.)	......	......	2	......
Weehawken Dry Dock Company, Weehawken, N. J.					
......	Freighters	7,500	......	14	105,000
......	Concrete Freighters	3,500	......	12	42,000
Western Pipe & Steel Company, San Francisco, Cal.					
Union Oil Company of California	Tanhkers	8,000	......	2	16,000
United States Shipping Board	Cargo	8,800	2,800	5	44,000

Shipbuilding for Private Account

New records of activity in shipbuilding for private enterprise are being made by the shipyards of the United States, says a statement just issued by the Atlantic Coast Shipbuilders' Association. Entirely exclusive of tonnage building for the Shipping Board, 263 steel vessels, aggregating 1,256,573 gross tons, are in hand for business interests.

If the present rate of progress is maintained, the 2,000,000 ton mark should be passed by June. Only a few months remain until the Government will have completed its construction program, and there is every evidence that the shipbuilding plants, freed of Government restriction, will be in a position to continue to meet whatever calls may be made upon them.

Huge Shipbuilding Program Under Way

The million and a quarter gross tons of steel steamers now under construction compare with a total of only 148,515 tons of all types of vessels building in the United States at the outbreak of war. The present construction figure is equal to the entire American output of shipping for 1914, 1915 and 1916, combined and 300,000 above the production for 1917. It is equal to the British output for

STEEL VESSELS UNDER CONSTRUCTION IN AMERICAN YARDS FOR PRIVATE ACCOUNT

Builders	Owners	Type	Gross Tonnage	No	Total Tonnage
Alabama & New Orleans Transportation Company	Pan American Petroleum & Transportation Company	Tanker	1,371	2	2,742
American Bridge Company	Sinclair Navigation Company	Barge	500	4	2,000
" "	Missouri Portland Cement Company	Barge††	300	3	900
American Shipbuilding Company	Builders	Freighter†	2,338	10	23,380
" "	"	Freighter*	4,500	4	18,000
Baltimore Dry Dock and Shipbuilding Company	Builders	Tanker*	8,000	2	16,000
Bath Iron Works	Crowell & Thurlow	Freighter†	5,600	1	5,600
Bayles Shipbuilding Company	Nyack Shipbuilding Company	Tanker*	950	1	950
Bethlehem Shipbuilding Company:					
Fore River	Atlantic, Gulf & West Indies Company	Tanker†	8,900	1	8,900
" "	Ore Steamship Company	Ore Ship*	7,150	1	7,150
" "	Sinclair Navigation Company	Tanker†	6,600	2	13,200
" "	Standard Transport Company	Tanker*†	8,900	2	17,800
" "	Standard Transport Company	Tanker†	8,900	2	17,800
Harlan Plant	Sinclair Navigation Company	Tanker*†	6,600	2	13,200
" "	Standard Oil of New Jersey	Tanker*	13,500	2	27,000
Sparrows Point	Atlantic, Gulf & West Indies Company	Tanker†	7,500	1	7,500
" "	Atlantic, Gulf & West Indies Company	Tanker*	8,000	2	16,000
" "	Standard Transport Company	Tanker*	8,000	1	8,000
" "	Standard Transport Company	Tanker†	7,500	1	7,500
" "	Standard Transport Company	Tanker†	7,150	2	14,300
" "	Vacuum Oil Company	Tanker†	7,150	1	7,150
San Francisco	General Petroleum Company	Tanker†	7,500	1	7,500
" "	Pan-American Petroleum & Transportation Company	Tanker*†	7,500	3	22,500
" "	Standard Oil of California	Tanker*	7,500	2	15,000
" "	Standard Oil of New York	Tanker†	7,500	1	7,500
" "	Standard Transport Company	Tanker*	7,500	2	15,000
Brunswick Marine Corporation	R. L. Smith	Scow††	2,000	2	4,000
Clinton Shipbuilding and Repair Company	Baldwin Locomotive Works	Lighter††	1,600	1	1,600
" " " " "	Atlantic Refining Company	Oil Barge††	600	2	1,200
" " " " "	Union Petroleum Company	Oil Barge††	326	1	326
" " " " "	Union Petroleum Company	Oil Barge††	1,200	1	1,200
" " " " "	A. C. Churchman	Barge††	326	1	326
Cramp & Sons	W. R. Grace & Company	Motorship†	6,300	2	12,600
" "	Florida & East Coast Railway	Freighter††	2,406	1	2,406
Oscar Daniels Company	Standard Oil Company	Tanker†	7,800	2	15,600
Downey Shipbuilding Corporation	Southern Pacific Company	Freighter††	4,000	3	12,000
Federal Shipbuilding Company, Kearney, N. J.	Freeport Sulphur Company	Freighter*	4,400	2	8,800
" " " " "	Standard Oil Company	Tanker†	10,000	5	50,000
" " " " "	United States Steel Corporation	Freighter*	6,000	10	60,000
Chickasaw, Alabama	Builders	Freighter†	6,869	4	27,476
" "	United States Steel Corporation	Freighter*	6,000	10	60,000
George A. Fuller Company	Builders	Freighter†	9,600	4	38,400
Greenport Shipbuilding Company	Bay State Fisheries Company	Trawler*	292	2	584
International Shipbuilding Company	J. A. Bandi	Freighter†	4,200	8	25,600
Johnson Iron Works	Cortez Oil Corporation	Oil Barge††	200	1	200
Kyle & Purdy	East Coast Fisheries Company	Trawler†	355	2	710
Long Beach Shipbuilding Company	Standard Oil of California	Tanker*	950	1	950
" " " "	California-Mexico Steamship Company	Freighter††	1,150	1	1,150
" " " "	Domingo Nazabel Company	Freighter††	1,200	1	1,200
Manitowoc Shipbuilding Company	Atlantic Fruit Company	Fruit Str.†	2,000	2	4,000
McDougall-Doulutt Company	Barnes Steamship Company	Freighter†	2,338	1	2,338
" "	Builders	Freighter†	2,338	4	9,352
McEachern Shipbuilding Company	Brooks, Scanlon	Freighter*	4,500	1	4,500
Merchants Shipbuilding Corporation	Union Oil of Delaware	Tanker†	6,250	2	12,500
" "	Shawmut Steamship Company	Freighter†	7,300	2	14,600
Moore Shipbuilding Company	Matson Navigation Company	Freighter*†	9,500	2	19,500
" " "	Standard Oil of California	Tanker*	950	1	950
" " "	Standard Oil of New Jersey	Tanker*	7,000	3	21,000
" " "	Vacuum Oil Company	Tanker†	7,089	1	7,089
National Shipbuilding Company	Pan-American Petroleum & Transportation Company	Tanker†	1,371	2	2,742
" " "	Cuyamel Fruit Company	Fruit Str.†	250	3	750
Newburgh Shipbuilding Company	Cuyamel Fruit Company	Freighter†	3,000	2	6,000
" "	Union Sulphur Company	Freighter†	4,700	2	9,100
New Jersey Dry Dock Company	East Coast Fisheries Company	Trawler†	355	2	710
Newport News Shipbuilding Company	Atlantic, Gulf & West Indies Company	Tanker*	7,000	2	14,000
" " " "	Standard Oil of New Jersey	Tanker*	13,500	2	27,000
New York Shipbuilding Corporation	W. R. Grace & Company	Tankers†	7,753	1	7,753
" " " "	W. R. Grace & Company	Tanker†	6,100	2	12,200
Pusey & Jones Company	Eastern Steamship Company	Freighter††	2,700	1	2,700
Schaw Batcher Shipbuilding Company	Union Oil of California	Tanker*†	8,000	2	16,000
Skinner & Eddy	Builders	Freighter*†	7,350	4	29,400
Southwestern Shipbuilding Company	Builders	Freighter*	5,300	1	5,300
Spedden Shipbuilding Company	Standard Oil Company	Oil Barge*	995	1	995
Standard Shipbuilding Corporation	Cuyamel Fruit Company	Fruit Str.†	1,500	2	3,000
G. M. Standifer Construction Company	Green Star Line	Freighter†	6,165	5	30,825
Staten Island Shipbuilding Company	Galena Signal Oil Company	Tanker†	2,500	1	2,500
" " " "	American Sugar Refining Company	Tanker*	4,200	1	4,200
" " " "	Standard Oil of New York	Barge††	420	6	2,520
" " " "	Standard Oil of New York	Bar e††	450	1	450
" " " "	Tidewater Oil Company	Tanker††	1,200	1	1,200
Submarine Boat Corporation	Builders	Freighter†	3,545	32	113,440
" "	International Products Company	Refrig.Str.†	1,400	2	2,800
Sun Shipbuilding Company	Atlantic, Gulf & West Indies Company	Tanker*	8,000	1	8,000
" " "	Atlantic, Gulf & West Indies Company	Tanker†	6,700	3	20,100
" " "	Gulf Refining Company	Tanker†	6,700	1	6,700
" " "	Pan-American Petroleum & Transportation Company	Tanker†	6,700	2	13,400
" " "	Rotterdamsche Lloyd	Freighter†	7,700	1	7,700
" " "	Sinclair Navigation Company	Tanker†	6,700	2	13,400
" " "	Standard Oil of New Jersey	Tanker*	8,000	2	16,000
" " "	Sun Company	Tanker*†	6,689	1	6,689
" " "	Union Oil Company	Tanker†	9,000	2	18,000
" " "	Societe Anonyne d'Orienent d'Industrie	Tanker††	8,000	1	8,000
Tank Shipbuilding Corporation	Southern Oil & Transportation Company	Oil Barge†	835	2	1,670
" " "	Southern Oil & Transportation Company	Oil Barge††	775	2	1,550
Texas Company	Builders	Tanker†	3,500	1	3,500
" "	Builders	Tanker††	6,700	3	20,100
Todd Shipyards Corporation	Sinclair Navigation Company	Oil Barge†	1,800	1	1,800
" "	Donald Steamship Company	Fruit Str.†	1,400	2	2,800
Todd Dry Dock & Construction Company	Stock	Freighter†	4,600	2	9,200
Union Construction Company	Standard Oil of California	Tanker*†	1,250	1	1,250
Union Shipbuilding Company	Aluminum Company of America	Freighter†	3,100	2	6,200
" " "	Builders	Freighter*†	7,150	2	14,300
" " "	Gulf Refining Company	Tanker†	6,100	2	12,200
Virginia Shipbuilding Corporation	Builders	Freighter*†	6,200	7	43,400

Total Building: 263 Ships, aggregating 1,256,573 gross tons.

NOTE: — * Classified by American Bureau of Shipping. † Classified by Lloyd's Register. †† Reported by United States Bureau of Navigation.

1915 and 1916 together, about 100,000 tons above the 1917 total, only slightly under the British production for 1918, and equivalent to about 75 percent of that for last year in the United Kingdom. It exceeds the entire world's production of ships in 1915. And it is greater than the entire seagoing tonnage of this country at the beginning of the war. The most significant development, however, is that the volume of new orders continues to replace the gaps made by the completion, cancellation and suspension of Shipping Board contracts.

Cargo Exceeds Tanker Tonnage

An interesting feature of the present return is that it shows that tanker tonnage, which a month ago, for the first time, exceeded the volume of freighter tonnage being built, has gone back to second place. There are now 620,000 gross tons of freighters building in comparison with 588,000 tons of tankers.

With the Shipping Board in possession of about 13,000,000 deadweight tons of vessels, the great bulk of which is composed of cargo carriers, the sale of which at low rates is being urged on Congress, the increase in private orders for freighters is a remarkable development. It may be taken to indicate that private enterprise, rather than take the chances of being able to supply its needs by waiting to select from a comparatively few types of ready-made ships, prefers to have modern ships built to its own designs with the assurance that they will be constructed for the particular service to which they are to be put.

Record Increase of Orders

In the matter of increase of orders the past month has set a record, as the following monthly summary of tonnage under construction in comparison with the previous month shows:

	Gross Tons Building	Increase Over Previous Month
October	347,343	....
November	550,714	203,371
December	805,147	254,433
January	977,488	172,341
February	1,256,573	279,085

The average increase per month since last October, when private construction began to reach sizable proportions, has been 227,000 tons.

How tanker tonnage, after steadily creeping up on the volume of carriers building, has lost ground is shown by the following comparison of the various types building at the different periods:

	Tankers	Freighters	Other Types
October	74,437	235,523	37,383
November	214,940	295,493	40,281
December	369,084	400,556	35,507
January	476,742	470,197	30,549
February	588,565	620,567	47,441

There is no evidence, however, that the demand for tankers is slackening, the increase of orders in hand for this type of vessel having been more than 100,000 tons during the past month. Construction for the Standard Oil companies still leads, but out of the total of 588,000 tons, more than half a million tons is for the account of other concerns

Of freighter tonnage, the largest amount under construction for one concern is comprised of twenty 6,000-ton vessels being built for the United States Steel Corporation.

Bethlehem and Federal Yards Lead

In the volume of tonnage building by the various shipbuilding companies the situation has developed into a close race between the Bethlehem Shipbuilding Corporation and the Federal Shipbuilding Company, the Bethlehem concern having taken the lead during the past month. Third and fourth places are held by the Sun Company and the Submarine Boat Corporation, respectively. The position of these companies in regard to number of vessels and tonnage for the past two months has been as follows:

	February		January	
	Number	Gross Tons	Number	Gross Tons
Bethlehem Shipbuilding Corporation	29	233,000	24	184,888
Federal Shipbuilding Company	31	206,276	35	208,276
Sun Company	16	117,989	14	98,717
Submarine Boat Corporation	34	116,240	12	38,250

Practically all of the Bethlehem and Sun companies' tonnage is composed of tankers, the Federal Company is building five tankers and twenty-six freighters, and the Submarine Boat Corporation has no tank steamers under way. All but two of the latter concerns' vessels are being constructed for builders' account and the growth of this class of work is a feature of the present return. The total of freighters taken over by the yards for their account is 74 vessels, aggregating 331,648 gross tons, 32 of which, totaling 113,440 tons, are for the Submarine Corporation. For the previous month, cargo carriers under way for builders' account aggregated 35 vessels of 142,158 tons. The volume of tankers taken over by builders is considerably smaller, because the Shipping Board has cancelled or suspended few of these accounts. The total now under construction is six vessels of 39,600 tons, compared with five of 32,000 tons for the previous month.

American Shipbuilders Show Faith in Vessel Market

The faith of the American shipbuilder in his ability to find a market for his vessels is shown by this volume of freighter and tanker tonnage, totaling 80 vessels of 371,248 tons, in comparison with 40 of 174,158 tons under way for builders' account in January.

With no marked improvement in the foreign exchange situation, American yards are still practically entirely dependent upon domestic orders—only one new foreign contract was recorded during the past month, a tanker for the Societe d'Armement d'Industrie. How small a part this class of work is playing in American ship production is shown by the fact that of the 1,256,000 gross tons building in this country only about 15,000 tons is to foreign order.

Distribution of the work among the various shipyards is an encouraging feature of the returns. Another increase in this respect is recorded, fifty yards now being engaged in construction for private account, as compared with 43 in January, 38 in December, 31 in November and 27 in October.

In addition to the records of the American Bureau of Shipping and Lloyd's Register of Shipping, the chief classification societies, the returns include a number of vessels given by the United States Bureau of Navigation but not reported as being classified.

Details of all the steel construction under way for private account are given in the table on page 283 prepared by the Atlantic Coast Shipbuilders' Association.

We Have the Ships! What Next?

BY CAPTAIN C. A. MCALLISTER, U. S. C. G. (RETIRED)*

The flood of new ships and the torrent of swollen freight rates have reached the crest and begun to subside. Already the high spots of normal conditions are discernible breaking through the receding waters of shipping turbulency. What does this mean? Is it the beginning or the end of our commercial venture upon the high seas? The observations of an "old salt" who knows the game, given in the following article, may help you to decide.

FOR several generations all true Americans have dreamed of the day when our flag would once again be a factor on the seas battling for commercial supremacy with our rivals. Almost as suddenly as the breaking of a dam, world conditions were thrown into a maelstrom involving nearly every nation on the globe. The cry heard above all others in this distressing period has been for ships and more ships. None among the nations responded so quickly and prolifically as our own United States. Vast of resources and bursting with patriotic energy America answered the call as never before could even have been dreamed possible.

So, among the flotsam and jetsam of this great disturbance, we find in our hands a mighty fleet of new ships ready to start in business for a merchant marine, after having fulfilled the shipping requirements of a great war and its immediate aftermath. I say "for a merchant marine" advisedly, as it is now brought home to us very acutely that something more than the ships is necessary to make a complete merchant marine. The phrase used extensively by a prominent cartoonist, "Now you've got it, what are you going to do with it?" applies with particular aptitude to our fleet of ships. It is "what are you going to do with it?" that concerns us all at the present moment.

What Are You Going to Do With It?

At the outset the writer wishes to record his unswerving belief that we are going to do the right thing with it. As a people we should now be thoroughly convinced as to the necessity of a merchant marine, and we will be untrue to the popular belief as to our national characteristic of shrewdness in money matters, if we let a more than three-billion-dollar investment in ships slip through our fingers without putting it to a profitable use. Hence, let all patriotic Americans who have ideas as to how we can bring forth the best results lend a hand at this critical period. From the writer's viewpoint the problem can be arranged under the following four general captions:

First.—Adopt the best methods of putting the ships into private control, as quickly as possible, without unduly sacrificing the Government's investments and without suddenly flooding the market for ship securities.

Second.—Americanize every function of the merchant marine: this to include operators, crews, insurance, classification, foreign agencies and banking facilities.

Third.—Popularize the merchant marine with the people by a systematic campaign of education, and the encouragement of small investors to place their money in shipping.

Fourth.—Economize in every function so that we will be enabled to meet the fierce competition of our rivals on the seas.

If those four general lines of endeavor are carried out to the best of our ability, the American people, with the intelligent backing of our Government in every legitimate manner, will demonstrate to the world that we can maintain a successful merchant marine.

Government Ownership Opposed

The first phase of the problem to be met is the disposition of the ships now the property of the Shipping Board. There is apparently but very little sentiment towards government ownership and operation, yet if the ships cannot be advantageously disposed of immediately, there is a strong sentiment that the Government should continue to own and operate. The main factors entering into the costs of operation are capital charges, depreciation, profit in the form of dividends, insurance, repairs, supplies and crew. The disposal of the ships now at about half their cost will, so long as these particular ships last, reduce the cost of operation in the matter of capital charge, depreciation and insurance to such an extent as to enable private operators to meet the competition of foreign ships not thus favored, and to that extent this plan is worthy of serious consideration. On the other hand, this method does not solve the problem of continuity of operation of the merchant marine.

Should the Government retain ownership and entrust operation to private parties, success could be obtained by the ownership disregarding capital cost, depreciation and profit as is done in all other governmental investments. That, however, is paternalism pure and simple. It would therefore seem logical to adopt a middle of the road policy, that is, to sell gradually to private operators having the capital and business at hand, and to permit new concerns to operate government-owned ships on a profit-sharing basis. Of course, in such an arrangement as this the greatest care would have to be exercised to prevent government-owned ships from competing with those privately owned.

Small Ships Should Be Sold At Once

As our enormous fleet was constructed primarily for war purposes and to best fulfill the immediate needs of great production, it is not naturally well balanced for commercial purposes. There is an excess of ships of the smaller type—those under 6,000 tons deadweight. A number of these can be used economically in our coasting trade and for feeders in certain branches of our foreign trade. The surplus of this type should therefore be sold abroad as rapidly as possible, as nothing deteriorates so quickly as an unused ship.

The disposition of the ships is after all a matter of discussion among ourselves. Under the second caption there is a more serious problem with which to contend.

Americanizing the Merchant Marine

With over half of the crews now operating our ships composed of aliens, many of them of the lowest order of intelligence, with hundreds of alien officers under temporary licenses, with two-thirds of our marine insurance placed with foreign companies and with half of the new

*Vice-president, American Bureau of Shipping, New York.

ships building for private ownership in this country having their plans approved, materials tested and construction surveyed by foreign agencies, is it not high time that we took action, and at once, by Americanizing our merchant marine? How can we succeed in our efforts on the seas when we lean so heavily on the facilities of those with whom we are to compete? It is hard enough for any newcomer in a contest to succeed, even when all conditions are favorable. What then can be expected of the novice who either ignorantly or stupidly borrows facilities from several of his rivals?

There are many weak-kneed among us, who say, "It can't be done! Americans will not go to sea! We are not a sea-faring nation, etc., etc."

I claim to the contrary and, as best evidence that it can be done, have but to point to our Grand Old Navy. Not so many years ago but that most of us can remember it, the same despairing cry was raised about the enlisted men in the Navy. Then, with an authorized strength of 25,000 or so, less than one-third were citizens. To-day, with over 100,000 men, the percentage of citizens is but a fraction below 100 percent. What has been done by the Navy can be done for the merchant marine.

True it is that the great masses of our population are remote from the seas, the majority probably never having seen salt water. Yet when you look into the ancestry of many of the farmers' sons in Minnesota, Kansas or other Western States, you will not have to go back many generations to find forebears who were New England fishermen, Scandinavian, English or other European followers of the sea. The call of the deep is latent in their predilections, and it has been demonstrated on innumerable occasions that men of such origin make the most efficient sea-farers in both the Navy and merchant marine.

Build Up a Naval Reserve in the Merchant Marine

The Shipping Board has conducted its own recruiting and training system and so far as it has gone has helped to a great extent. It is evident that additional means will have to be adopted, as the percentage of citizens among the Shipping Board crews is still less than half of all those employed. While the writer would be the last to advocate military training and discipline on strictly merchant ships, there is little doubt in his mind but that a system can be devised whereby many of the officers and men on merchant vessels can be enrolled in a naval reserve, and receive sufficient retainers from the money appropriated for the national defence to make up the difference between American wage schedules and the wages paid to corresponding grades on foreign ships. In times of war the Navy would benefit by having a large number of officers and men available for military duty, whose experience in ship handling had been as good or better than that obtainable on naval vessels in times of peace. Arrangements could be made whereby a certain small period of each man's enlistment could be spent on naval vessels for drill in strictly military duties.

The Navy recruiting system should be brought to aid this Americanization of the merchant marine. This system, so ably worked out, has accomplished wonders for the naval personnel, covering as it does all parts of the country. The higher pay, freedom from military discipline for the greater part of their enlistment, and above all the natural preference of young Americans to accomplish something constructive in times of peace, should make enlistments for the naval reserve comparatively easy. With the combined efforts of the Shipping Board training service and the naval recruiting service, it will not be long before our ships will be manned by all American crews. Whatever steps are necessary to accomplish this are well worth while, and nothing should be left untried to bring about this most desirable result.

Whether sailors unionize or not is a matter of small moment so long as they are American citizens. The aliens among the licensed merchant ship officers will soon after the declaration of peace have to become citizens or give up their American licenses.

American Insurance and Classification

The Americanization of insurance and classification facilities is being given the careful scrutiny of a very intelligent committee of Congress, and there seems to be little doubt of the passage in the near future of remedial laws covering both these collateral functions of a merchant marine. We must have both of these facilities under our control and management, and not depend upon foreigners to any degree. Aside from the advantages given to our competitors by the practical control of these vital necessities, it is a drain on the finances of the country, as there is absolutely no reciprocity in either of these transactions.

Popularizing the Merchant Marine

Under the third caption of popularizing the merchant marine, we open up a hitherto untrodden field of effort in this country. What can be accomplished along these lines is best illustrated by what happened in Germany. Many of us can remember when the German commercial fleet occupied about the same relative position as ours did in the years immediately preceding the world war. Realizing that their hopes of national expansion rested upon the building up of a merchant marine, they embarked upon an extensive campaign of educating the people both as to the necessity for ships, and in the art of building them. Graduates of their technical schools swarmed to the Clyde and soon imbibed knowledge and experience from the Scotch shipbuilders, who had for generations been studying the subject. Text books on the value of shipping were introduced in their schools and colleges and made parts of their curricula. Aided in every manner possible by all branches of the government, their efforts rapidly bore fruit, so that by the time they had arrived at the state of mind to commit hari kari, they had a merchant marine in size and importance second in the world. In creating this great fleet they had also annexed the reputation of having built the fastest transatlantic liner, as well as having constructed the largest ship the world has yet seen, now by the fortunes of a most righteous participation in the great war about to become the bell-wether of our Yankee fleet of merchantmen.

With no fear of such a disastrous ending to our maritime efforts, we might well emulate some of the methods which created that fleet. The chairman of the Shipping Board very wisely said in a recent address that for us to succeed, the people must be taught to think in terms of ships. No better plan could be adopted than for Congress to require through the Bureau of Education the dissemination of standard books on the subject to the various educational institutions throughout the country, with a request that a knowledge of the fundamentals of shipping be imparted to every student. The States should require the institution of a brief course in shipping essentials in every college, academy and high school within their jurisdictions. Organizations like the Marine League and the American Merchant Marine Association should vastly increase their membership, and send competent lecturers throughout the land to preach the advantages of a merchant marine to all the people.

American citizens now have vast sums of money to invest in legitimate enterprises. Someone more versed in financial matters than the writer should devise means whereby the small investors may put their funds in shipping enterprises with a modicum of safety. Railroads, in a growing country, have proved to be attractive investments, but now that they are no longer attractive as expanding corporations, much of the money could well be placed in ships. Mortgage laws should be enacted which will protect the investors, and overcapitalization should be prevented by federal supervision of incorporation.

Under the fourth caption of economizing in all mercantile marine functions arises the most complex of the problems before us, as upon this phase depends to a great extent the survival of our fleet in the competition to come.

Economical Operation of Ships

An illiterate general when asked his opinion as to the acme of military strategy is alleged to have replied: "Get there fustest with the mostest men." This might well be paraphrased in defining the acme of maritime operations, as "Carrying the mostest cargo for the leastest money."

In the mad haste of the war all efforts at economy have been thrown to the winds. "Getting there fustest" has been the motto and the "leastest money" has cut but very little figure in our shipping activities. Now, however, we have got to reckon with costs in every manner possible. Wage costs follow natural conditions of supply and demand more nearly than any other element. Decreasing demand and increasing supply will soon bring that element to the normal. If we can help out our crew costs with the naval reserve aid, as hereinbefore mentioned, we need not greatly fear competition from that source. The overhead items of capital cost and depreciation will be less discriminating than ever before, on account of the gradual drawing together of the building costs at home and abroad. This drawing together is accelerated by our lower cost of steel. While we can continue to sell ship material to England and Japan, as we are now doing and have done for some time, that will always be one factor in our favor. Our shipyard labor may never be as low as that of our rivals, but there probably will never again be as wide a variance as there was in pre-war years.

Fuel cost for ship propulsion is the one factor where we should gain over our rivals, and our possession of two-thirds of the world's oil supply is the great natural advantage we have in the race. If we take full advantage of that, we can almost overcome our disadvantages. Fortunately we have a larger proportion of oil-burning vessels in our merchant fleet than any other nation.

Our Advantage in Oil Fuel

The increased cargo space, the decreased number of crew, and the less cost of oil fuel as compared with the corresponding items on vessels using coal as fuel, are too well known to dwell on at length in this discussion. We should push this advantage to the utmost, and if we cannot succeed by other means, the public oil and shale lands should be set aside for the exclusive use of our merchant marine. Some would go even further and carry out to a greater extent the system already adopted by the Shipping Board of establishing fuel stations in all parts of the world, accessible to all American trade routes by having the Government produce the oil, transport it to these outlying stations in tankers owned by the Government, and sell it to all American owned merchant vessels at the bare cost of production and delivery. It is claimed that we would thus be utilizing one of our great national resources for the benefit of the country at large, as all shades and sects of our population are directly or indirectly benefited by our possession of an efficient merchant marine.

To show the possibilities of a scheme such as this, I have but to quote the cost of fuel oil in one of our island possessions. Less than a year ago oil was sold to our merchant ships at a cost of $16 (3/6/8) per ton; now, since the establishment of a Shipping Board oil station, it is sold for just about half that amount. In the language of the official who showed me those figures, "Why argue about a few dollars' difference in pay to sailors as a deterrent to our merchant marine?"

In conclusion the writer desires to state that he is now, and always has been, a firm believer that we would eventually have a large and successful merchant marine. Now is the time, if ever. Some of my contentions may be overly optimistic, but if all true Americans will work together along the lines indicated herein, or along any other good lines having the same object in view, our success is assured.

What the Steamship Owners Recommend

BY H. H. RAYMOND, PRESIDENT AMERICAN STEAMSHIP OWNERS' ASSOCIATION

The American Steamship Owners' Association, whose membership includes practically all of the corporations, firms or individuals that own and manage ocean-going steamships under the American flag in coastwise, West Indian or overseas commerce, from New England to the Gulf on the Atlanitc side, and also the principal companies whose home ports are on the Pacific Ocean and whose members own upwards of 2,500,000 gross tons of their own steam shipping, and in addition operate about 4,000,000 tons of Government-owned vessels of the Shipping Board fleet, has unanimously adopted the following resolutions, with a view to assisting Congress in the shaping of a definite, constructive National merchant marine policy:

Steamship Owners Resolutions Adopted November 10, 1919

Resolved, That in the opinion of the American Steamship Owners' Association, it is essential to the permanent success of an American merchant marine that the vessels comprising it should be owned and operated by American individuals, firms, corporations and associations.

To this end the association recommends:

(1) That steamers of less than 6,000 tons total deadweight capacity be promptly sold, with privilege of transfer of flag, at such prices as may be obtainable. That the Shipping Board be directed to sell as speedily as possible, and in any event within two years, all the remaining merchant vessels constructed or owned by the United States, including the ex-German tonnage, at world market prices (having regard to sales made by other governments since the armistice) to American citizens, firms or corporations, on terms of 25 percent cash and deferred payments of the balance of the purchase price over periods of ten to fifteen years, and deferred payments to bear interest at a rate not exceeding 5 percent and to be secured by a first mortgage.

(2) That after the sale of a portion of the fleet of vessels of over 6,000 tons total deadweight capacity each, the unsold remainder should, as far as practicable, be allocated by the Shipping Board to those who have purchased, on a basis of

payment of a commission to the operating firms or corporations and payment by the operators of the proportion of the consolidated net earnings of the ships owned by such operators and the Government-owned tonnage which the operated tonnage bears to the total tonnage operated by such firms or corporations.

(3) That all individuals, firms or corporations who shall purchase and operate ships in the foreign trade, in pursuance of the foregoing plan, should be exempt in respect to the earnings of such ships from all Federal excess profits taxes for a period of ten to fifteen years. Provided that such individuals, firms or corporations be permitted to charge off 10 percent of the net earnings of such ships on account of depreciation, and deduct such amount in their tax returns as operating expenses, and provided further that an amount of earnings equivalent to the excess profits taxes that would otherwise be payable shall be invested by such individuals, firms or corporations in the building of new tonnage in American shipyards or in the purchase of tonnage built in American shipyards.

(4) That the Government should enact special legislation to assist existing passenger lines in the construction and operation of new passenger tonnage of the highest class and latest design and type, and to inaugurate and develop additional passenger and freight lines on routes on which it is desirable in the national interest that direct passenger and freight service should be established.

At another meeting of the Association on January 27 the resolutions of November 10 were unanimously reaffirmed, and in addition certain amplifying resolutions were adopted, as follows:

Resolved, That we particularly reaffirm the recommendation that government-owned ships of over 6,000 deadweight tons be sold only to American individuals, firms and corporations to be retained beneath the American flag.

American sea wages have always been higher than the sea wages of other and competing countries. This fact throughout our existence as a maritime nation has made it necessary for American shipowners to conduct their business with the utmost enterprise and economy, to adopt all possible labor-saving improvements, and, generally speaking, to operate larger ships than their rivals in ocean commerce. Our earlier maritime experience emphasizes the truth which all maritime men of today understand, that it is the relatively large sailing ships which can be made most effective and most profitable by American shipowners. A steamship of 8,800 or 9,600 deadweight tons requires no more deck officers or engineers than a steamship of 5,000 deadweight tons, and only a few more in number of firemen and seamen. That is to say, in the larger ships, carrying a larger cargo, each officer and man renders proportionately a greater carrying service than in the smaller ship—an economic fact of the utmost significance to the Nation that pays the higher per capita wages.

Moreover, American trade is characteristically a trade of relatively large cargoes, and many, in fact most of these cargoes, are carried long distances. On this account, again, the most advantageous ship for our purpose is the larger one. Those steamers of upwards 6,000 deadweight tons are the best hope of the American marchant marine of the future, and we recommend most earnestly that they be sold only to American citizens or corporations for the purpose of serving American commerce.

Another point on which we wish to lay emphasis is embodied in our second Resolution:

Resolved, That government-owned ships of less than 6,000 deadweight tons be sold preferably to American citizens, so far as there may be need of such ships in carrying American commerce, and that such of these ships be sold to foreign citizens or subjects with the privilege of a change of registry as the Shipping Board, after inquiry of all steamship owners and operators, shall decide are not required for the development of American trade routes or for the promotion of an efficient merchant marine. American purchasers should also have the right of resale to foreign subjects with the privilege of transfer of registry.

While the relatively large ship is the most valuable ship for the uses of our country, these smaller vessels of less than 6,000 deadweight tons in certain trades, as to the West Indies, for example, or on new routes which would have to be developed, are not without their desirability. Therefore, we believe that American citizens should be given the first choice in the purchase of these vessels, that they may be assured of all they desire for the development of new rontes or for use as feeders to the larger American ships, and that only those that do not seem to be required for our commerce be sold to foreigners for service under foreign flags. If the Government is to be authorized to sell the surplus of our lighter tonnage to foreigners, it is obvious that it would be just to authorize Americans who have purchased these ships to sell them also to foreigners when they have served their purpose and larger and newer vessels seem to be required. American owners of the smaller craft, therefore, should have equal opportunity with their government to dispose abroad of those that are not required for home use at any time.

Another point on which we would make an earnest recommendation is this:

Resolved, That it is the sense of the association that having regard to a proper equalization of capital charges with those of our principal foreign competitors, in point of depreciation, interest and insurance, all single-screw steel-built steamers of the government-owned fleet, of 12,900 deadweight tons and under, should be sold, as above recommended, at a price not exceeding $100 (20/16/8) a deadweight ton, depending upon the type, class and condition, with a proper allowance for depreciation for age, and with exemption for from 10 to 15 years from Federal excess profits taxation if employed in the foreign trade.

We specify ships of 12,900 deadweight tons and under in this resolution because all of the distinctively cargo-carrying steamships of the Government-owned fleet are of below 12,900 deadweight tons—the only larger vessels being the troop ships that are being constructed as passenger and cargo liners and are upwards of 13,000 tons and of high speed. These liners, of course, are worth a higher price than the slower single-screw cargo vessels.

It is our sincere conclusion, after a long and careful discussion of the matter, that $100 (20/16/8) a ton represents a price for the Government-owned cargo ships that cannot be exceeded if American shipowners who purchase them are to have anything like a fair and even chance in competition with the shipowners of other nations. It must be remembered that steel cargo steamers similar in type, and most of them, probably, of greater actual value than the ships of the Government-owned war-emergency fleet, could have been and were constructed in this country before the war for as low as $60 (12/10/0) to $65 (13/10/10) a deadweight ton. There were relatively few of these steel general cargo steamers in our merchant marine before the war, but there were thousands of such ships in the merchant fleets of Great Britain, Germany, Norway, France, Italy and Japan. In fact, some of these foreign-built cargo steamers were produced in the years before the war at as low a price as $30 (6/5/0), or even $35 (7/5/10) a deadweight ton. Great Britain, after all her war losses, still possesses upwards of 20,000,000 deadweight tons of ships that were in service before the war, and the average cost of these vessels, most of which are still good and serviceable, must have been well below $60 (12/10/0) a ton—liners, of course, not included. The high profits of the war period have probably enabled most British shipowners to mark their existing tonnage down to a nearly nominal valuation.

It is with this relatively low-cost shipping of the world's pre-war fleets that the high-cost steel steamers of the Shipping Board must go into close, sharp competition.

(*Concluded on page 292.*)

Suggestions from the Shipbuilders

Views Expressed by Shipbuilders and Naval Architects Regarding the Future of the American Merchant Marine

IT is evident that the country has more ships intended for deep-sea service than it has organizations to operate and crews to man them. There are without doubt many ships that are unfitted for long trade routes, and possibly a surplus of good vessels for the shorter routes. If there are vessels which, on account of size, type, or arrangement, are not fitted for a particular trade or service, they should be sold, regardless of size, and if there are ships of poor design or structurally weak, they should be scrapped. Incompetent operators and crews should also be scrapped, for it is just as important that ships should be operated by capable managers and navigated by competent crews as it is to have the vessels well designed and structurally sound.

We have today many efficient individuals and organizations operating American vessels, but unfortunately there are not enough of them. It is hardly fair to expect that this country could, within a period of two or three years, build up organizations to operate the hundreds of ships we have built for ocean trade, that would equal those of other nations that have been operating deep-sea vessels for scores of years. In my opinion, if this country is to build up a solid, efficient and lasting merchant marine, it must be done through private initiative and enterprise, with the help, and not interference, of the Government.

M. E. Farr, President, American Shipbuilding Company.

IT is well known that the commerce of the world is largely carried by the ships flying the British flag; therefore, it is inevitable that if the United States is to take its proper place among the world carriers, a certain portion of the trade now carried by Great Britain must be taken over by the merchant marine of this country.

The treaty now in force between this country and Great Britain pertains entirely to direct commerce between the United States and Great Britain and its dependencies in Europe. Great Britain, at the time of making the treaty, absolutely refused to extend the treaty to its colonies, desiring to reserve that trade entirely for English ships.

At the present time it is understood that about 60 percent of the merchant marine of Great Britain is engaged in carrying foodstuffs from its colonies and other countries to Great Britain itself. It would therefore seem that the remedy for American shipping lies in getting into the world trade at once and in placing a heavy tax upon foreign vessels engaged in the indirect trade with this country; i. e., if a vessel, carrying the British flag, engages in trade between countries of South America, or its own colonies, and the United States, this vessel would be in the indirect trade and subject to the tonnage tax in addition to the duties already provided for in our own tariff laws.

Another aid that may be given to American ships is the granting of some form of rebate to the present duties to all importers and exporters bringing their goods to, or taking them away from this country in vessels flying the American flag. It may be that this form of legislation would make necessary the revision or total abrogation of treaties now in force between the United States and foreign countries: if so, it seems to me high time for the United States to notify such countries that it desires to terminate treaties antagonistic to the best interest of the Nation's merchant marine. If we have been careless in the past in guarding our sea rights, we should at once set about improving our position.

Another thing which militates against the best interest of the shipping trade is the very onerous exactions of the Seamen's Act, which causes the running expenses of our vessels to be increased out of proportion to those of foreign countries. Action should be taken in Congress modifying the present Seamen's Act to make it more nearly conform to the laws of Great Britain.

Another feature would be to retain in this country the cargo vessels built by the United States Shipping Board—at least all the vessels over 6,000 tons—and the sale of such ships guarded so that they could not be resold to steamship companies flying a foreign flag. These vessels should be used either by American steamship lines, or by the Shipping Board, in instituting new lines to ports where no American lines exist.

W. A. Dobson, Naval Architect, William Cramp & Sons Ship & Engine Building Company.

THE main questions, before the country to-day are: (1) what to do with the present ships, (2) what is to be our future policy, and (3) what must be done to retain our fleet and make it an operative possibility in face of competition? The question of the actual Government operation of ships is one that can be dismissed in a few words—*it won't work*. Anyone who is at all familiar with the business knows that this is true, despite any paper arguments that may be advanced to the contrary. But the Government may own or retain a partial interest in vessels, leaving the same to be operated by commercial firms at such terms as will be reasonably profitable to both parties. One fact should not be lost sight of in this connection. Even if it might appear that small, if any, profit accrued to the Government in the actual deal so far as the ships themselves are concerned, the indirect profit to the country as a whole from increased trade, stimulus to new trades, developments of new trade routes, etc., would represent an incalculable value—to the farmer, manufacturer, laborer, and, in fact, to the whole populace.

To attain this end, the second condition, i. e., future policy, must also be considered. It is useless to adopt half-hearted means to accomplish anything, and some definite and well-established policy to "see the thing through" is essential. No business has ever attained success unless those concerned have been continually looking into the future and anticipating, as far as possible, or creating, if necessary, future developments. The same is particularly true in connection with shipping. A sane or conservative programme, extending over a period of years, would not involve the country in any very serious financial obligations—almost microscopic when compared with some other expenditures such as pensions, etc.—and would do much, not only in making us more or less independent of the foreigner, but also in insuring the ultimate success of the merchant marine.

The third condition, i. e., making the fleet an operative

possibility, is one where perhaps the Government is more especially a factor. It is a truth, and, I regret to say, a sad one, that practically every bit of legislation by Congress in relation to the merchant marine in the past decade or more has rendered the operation of ships less and less profitable or even impossible—at any rate it could not be called "constructive legislation" in the wildest flights of imagination. The removal of certain of these handicaps is of primary importance; and it argues poorly for the far-sighterness of certain legislators if, with the idea of gaining a great advantage for certain classes of labor, at the same time they so arrange things that this very labor that they wish to assist is driven out of a job.

The last, and probably the most vital, point where the Government can assist is in the establishment of trade centers and organizations in foreign countries. Ships are of no use unless you can have cargoes for them, and one of our present and greatest handicaps in foreign trade is the lack of proper agencies to get the goods for our ships. Other maritime countries have realized this, and the sooner we do, the better. Foreign cargoes are not apt to be hanging around, like fruit upon the trees, waiting to be plucked by any chance passerby; and it is only after proper and extensive connections have been established that there can be any hope of a successful mercantile marine.

In conclusion, contrary to the results of many other war activities which have to be written off as a dead loss, we have in our ships a real peace-time asset; and it only needs a little imagination and constructive legislation to make this a real benefit to the country as a whole.

H. C. Sadler, Professor of Naval Architecture, University of Michigan.

IT is my firm belief that the ships should be sold to American owners at the present market value of similar ships, with the understanding that the owners will pay 20 percent of the cost of the ship on taking possession of same and the Government will accept a mortgage on the ship for the balance at 3 percent interest, and with the further stipulation that additional payment of 10 percent of the cost price of the ship should be paid each year.

The ship should carry a certain number of officers and crew in the Naval Reserve unit, and preference should be given American-owned ships in connection with the facilities provided by the United States Government even at the expense of abolishing present trade treaties.

E. H. Ewartz, General Manager, Moore Plant, Bethlehem Shipbuilding Corporation, Ltd.

PROPER consideration of the following items I believe to be vital to the successful maintenance of the merchant marine of the United States. Briefly, these are three things:

(1).—A proper revision of the navigation laws, including a thorough revision of the laws for the measurements and inspection of merchant vessels by the United States Steamboat Inspection Service.

(2).—A system of properly financing individual ship operating companies of small caliber that will permit of the establishment of a large number of small operating companies which operate two, three or more ships, with the holdings in these vessels widely distributed in small lots.

(3).—A preferential treatment as far as tonnage dues for United States vessels through the Panama Canal.

H. A. Everett, Naval Architect, Union Shipbuilding Company.

MY suggestion would be that Congress should lay out a shipping program covering five years, during which time the people could be educated to the importance of the shipping proposition and realize how important it is to the nation. For the first two years the ships would be sold at $200 (41/13/4) a ton, and any American who wanted them could go in and buy them at that price. At the end of that period there would be a drop in the price. I would not suggest any definite figure. The price would depend upon conditions, but it ought to be sufficient to maintain the general American market, say around $175 (39/9/2) a ton. This price could be held for one or two years, when there could be a further drop in price, and at the end of the five years the remaining ships could be sold for what they would bring and the Government get out of the shipping business. During the five-year period the unsold ships could be allocated to ports as they are allocated now, on a profit-sharing basis.

This would give time for the establishment of new trade lines; it would give time for the education of the people to the importance of the shipping industry; it would give time for the average business man to learn the personal and business advantage of investment in ships; it would give time for the shipyards to do away with war methods and get down to an efficiency basis on which ships could be built in competition with the Clyde while still maintaining the high wages of American labor.

I am opposed to the plan of throwing our Government ships on the market at anything like the price of $140 (29/3/4) a ton. I want to see the Government's investments in the ships protected. I would like to see every port on the Atlantic and on the Pacific share in the fullest degree in the development of an American merchant marine, and get all the benefit that can come to them from foreign commerce. I am anxious to see the people of this country become a shipowning people; I would not like to see our great fleet pass to a few hands, no matter how strong and efficient they might be, and I would not like to see two or three ports and a few people reap the benefits that can come to the whole seaboard and to many thousands of Americans from the revival of the American merchant marine.

Holden A. Evans, President, Baltimore Dry Docks & Shipbuilding Company.

IN formulating our policy it should ever be kept in mind that the American merchant marine must be established in the face of strenuous opposition from foreign countries, whose citizens, from years of experience in operating vessels in world-wide markets, are already established in a commanding position that makes them strong opponents and competitors. It appears, therefore, to be absolutely essential for the next few years that some kind of preferential treatment be extended to American ships, built in American shipyards and operated in the overseas trade by American citizens. It must be a policy of wisdom and encouragement in order firmly to establish our merchant marine as one of the country's greatest assets.

Selfish and short-sighted American interests are demanding that these vessels—built with money contributed by the citizens of this country—be sold at what is little better than sacrifice prices, and this propaganda is being fostered and encouraged by lobbyists representing powerful foreign shipowning interests. So insistent and insidious is this propaganda that the country is facing a chaotic state of mind in which the necessity of establishing a national policy is lost sight of and the immediate

sacrifice sale of ships, regardless of future policy, appears to be the paramount interest.

The national policy should also be formulated so that vessels now operated by the Shipping Board may be sold upon easy terms to private American citizens or American shipowning or ship operating firms. The terms of sale should require an initial payment of not more than twenty percent of the total value of the vessel. The payment of the remainder of the principal sum should be extended over a period of approximately ten years.

The immediate establishment of a national policy for the operation of the American merchant marine is imperative. Until such a policy is definitely determined, neither the banking interests nor the public will be attracted to invest money in the purchase and operation of ships, and failing such investing interests our merchant marine is doomed to failure. With a wise and well defined policy there appears to be no reason why the United States should not possess a merchant marine in keeping with the value of its commerce and its position as one of the leading and dominant countries of the world.

E. C. Bennett, Vice-President and General Manager, Newburgh Shipyards.

THE main points to be borne in mind by the general public are the lessons learned during the war. First of all, it is absolutely necessary that we have a large seagoing merchant marine, not only for the advantages in peaceful trade, but so that we shall not be caught again in a war without ships for transporting men and supplies and as auxiliaries to our navy; and, also, that we shall have trained seamen, deck officers and engineers of American nationality, capable of handling our fleet in wartime.

A consideration of the American merchant marine from a purely commercial point of view brings up the question whether the Shipping Board shall continue to operate the bulk of the ocean-going vessels sailing under the American flag or whether our traffic shall be handled by private ownership. There is no doubt that competition with the other maritime nations will shortly be as acute as ever before, and to be able to compete with foreign ships more cheaply built and more cheaply operated, we will have to have a subsidy or a reduction of import duties on goods carried in American bottoms.

It would be advisable to have a competent Board established, as is the arrangement in England, to revise the laws covering shipping. We have on the statute books, at present, a great many hampering laws written in for the most part by politicians, knowing little or nothing of the business of shipping, or laws promulgated by the labor unions, which make such drastic changes as permitting a sailor to break his agreement and desert the ship at any time . This last is directly in conflict with the laws of practically all the sea-faring nations.

Before the war the average business man's opinion was that, if foreign ships could carry goods cheaper than American ships, without a subsidy, why have a merchant marine? Then came the war, and where did we get off? We rushed into shipbuilding at enormous expense, and managed to build up a merchant marine, by the time the war was over, of considerable size, but at a surplus cost many times greater than a subsidy would have been to have built up this fleet gradually in peace times. The result is that we have a fleet of cargo ships, costing about \$225 (46/17/6) per gross ton. We must compete with England, who is building ships at \$150 (31/5/0) per ton, and whose pre-war ships cost less than \$100 (20/16/8) a ton.

We lost in the war 73 percent of the sea-going steamers that we had in service when the world war was started. We will soon have fourteen million tons of shipping on the high seas, almost all new ships (excluding the captured German vessels). How can we continue to operate them after the present high freight rates have fallen to normal, owing to foreign competition? (This will occur, in the opinion of the writer, in less than three years.) The answer is clear, let the Shipping Board sell the ships to American owners at about \$125 (26/0/10) per ton and charge the difference off as a war loss, mainly owing to those obstructionists who have for years passed legislation preventing the normal building up of our merchant marine.

J. Murray Watts, Naval Architect.

MY opinion on the future policy for our merchant marine is best expressed by the following resolution, adopted by the Atlantic Coast Shipbuilders' Association and read before the committee on commerce of the United States Senate:

"That Congress is hereby earnestly requested to proceed at once to the formulation of adequate legislation necessary to maintain an American merchant marine; that in such legislation every discrimination be made in favor of American ships owned, controlled and operated by American citizens, and officered and manned by Americans, whether such discrimination be in the form of duties, tonnage taxes, terminal preferences and incident railroad transportation, or postal and admiralty subventions, or any or all of these, as the nature of the several trades may require, and,

"Be it further resolved:

"That Congress is further urged to provide for a naval or marine wartime reserve, composed of officers and sailors of the American merchant marine, with such rank and pay as Congress may deem fit, or as may be fixed by its accredited agencies, and,

"Be it further resolved:

"That until adequate shipping legislation has been enacted, that Congress is respectfully urged not to authorize the disposal of more than 20 percent of the steel ships of the United States of greater burden than 4,000 tons.

"Be it further resolved:

"That Congress shall provide by appropriate legislation that whenever any steel vessel of more than 4,000 tons owned by the United States, shall be sold by the United States at any time hereafter as hereinbefore provided, such vessel shall not thereafter be conveyed to, nor in any manner controlled by, any foreign citizen, or corporation, except with the permission of Congress, or such public agency as Congress may designate."

R. H. M. Robinson, President, Merchant Shipbuilding Corporation.

IN my opinion, the logical development of the merchant marine can be best accomplished with private ownership of vessels, the operation of such ships, however, to be under the American flag with Governmental assistance and aid for such operation.

The United States Shipping Board should establish a fair and reasonable price for the sale of its vessels to private interests—such price to be standardized and to take

into consideration the difference between excessive war costs and present values. The Government should charge off this difference as part of its war cost.

In the sale of such vessels care should be taken not to sacrifice the private interests of those citizens who have already purchased vessels from the United States Shipping Board, and an equality should be established which would not give preference to contemplated purchases.

There should be no attempt on the part of the United States Shipping Board to regulate trade routes and rates. If we are to operate a merchant marine in competition with foreign countries, there should be no such restriction, and the business should be based entirely upon supply and demand and competition.

To have the Government sacrifice millions of tons of shipping by the establishment of a receivership and selling to foreign countries such vessels as we have built would be unfortunate for the future upbuilding of our merchant marine, which is so vital and so necessary for the future development of this country.

Ernest Lee Jahncke, President, Jahncke Dry Dock & Repair Company, Inc.

What the Steamship Owners Recommend

(*Concluded from page 288.*)

Successful competition will be entirely impossible, if American vessels are to be capitalized at any such figure as \$220 (45/16/8) to \$225 (46/17/6) a deadweight ton, at which the Shipping Board now holds its war-built tonnage. The whole case is clearly and briefly stated in this comparison of the charges on capital invested in two similar vessels of 10,000 deadweight tons—one furnished to British shipowners by the British Government at a cost of \$100 (26/16/8) per ton, and the other furnished to American shipowners by our Shipping Board at a price of \$220 (45/16/8) per ton:

	British Ship (\$1,000,000)	*American Ship* (\$2,200,000)
Insurance, 3 percent	\$30,000	\$66,000
Depreciation, 5 percent	50,000	110,000
Interest on investment, 5 percent	50,000	110,000
	\$130,000	\$286,000

Difference in favor of British vessel, \$156,000 (£32,000), or equivalent to 15.6 percent on cost of British vessel.

Whatever may be said about the higher cost of wages of American officers and crew as compared with British officers and crew, this difference falls into insignificance as compared with the difference based upon capitalization charges. It is essential to the success of our merchant marine that capitalization and the costs consequent upon it should be equalized—and this fact will be found to be true whether the present Government-owned fleet is turned over to experienced shipowners to operate, with the thrift and enterprise which they best understand, or is retained for operation by the Government. If the United States were to keep these war-built ships and endeavor to compete with the shipping of the world, the first thing the Government would have to do would be to write the cost of its vessel down to \$100 (20/16/8) a deadweight ton. If this were not done, and if the Government-owned ships were indefinitely operated at a loss, the American people would insist on abandoning the experiment.

While the difference in the annual cost of maintenance between a British ship of 10,000 deadweight tons and an American ship of the same capacity—the former sold by the British Government at \$100 (20/16/8) a ton, or a total cost of \$1,000,000 (£205,000), and the latter held by the American Government at \$220 (45/16/8) a ton, or a total cost of \$2,200,000 (£452,000)—would be as set forth above, \$156,000 (£32,000), based on the three essential factors of insurance, depreciation and interest, the difference in cost of maintenance due to the wages of officers and crew would be probably not in excess of \$12,000 (£2,460), with a tendency to decrease if British sea wages goes still further toward an equality with our wages.

Equalizing Wage Costs

To equalize this difference in wage cost—which, it must be borne in mind, is a relatively small and probably decreasing factor—our resolution suggests that an allowance of 10 percent of the net earnings of American ships be granted on account of depreciation, and the amount deducted as operating expenses in the tax returns.

Our resolution, moreover, provided that, for the important purpose of directly encouraging American shipbuilding, ships bought from the Board and kept under the American flag be exempted from Federal excess profits taxes on condition that an amount equivalent to such exemption be invested by the owner in the purchase of additional tonnage constructed in American yards. Of all our great national industries, American shipowning and shipbuilding for overseas commerce have been left without aid and encouragement from the Government—other industries, as we all know, having long been protected in some degree or other by national tariff laws. We admit that it must be acknowledged that ocean shipbuilding and navigation are as much entitled as any other industries to some form of national aid against foreign competition.

Our final resolution is:

Resolved, That in the allocation of Government-owned ships that may be unsold after the remainder of the fleet has been disposed of to private ownership and control, preference be given as far as practicable to those American individuals, firm or corporations that already own ships or purchase Government-owned tonnage, and thereby contribute to a complete, privately owned and controlled merchant marine.

In this declaration we do not propose that the Government-owned ships that may be unsold be allocated only to those who already own ships or who purchase the new Government tonnage. We have no desire of suggesting any monopoly of any kind. But we hold that because those who already possess ships or who put their money into the purchase of Government-owned ships and employ them in the foreign trade are directly assisting toward the establishment of a permanent American ocean shipping, and assume responsibilities not incurred by those who only operate and do not buy Government-owned ships, the actual American shipowners should equitably be given a reasonable preference in the further allocation of Government tonnage. We believe that this is a fair and open proposition that, if properly understood, will commend itself to the approval of all men.

National Interests Must Be Conserved

It is our opinion that the majority of the sound concerns now operating Government-owned ships will acquire some of this tonnage if it is offered at a just price, with an assurance of essential national aid hereafter, that the number of American shipowners will be greatly increased by the policy which we have outlined, and that the newly purchased tonnage will be distributed among Atlantic, Gulf and Pacific ports in exact proportion to their needs and opportunities. We stand unequivocally for a broad national interest in shipowning and navigation under the American flag.

Maritime Legislation Before Congress

Review of Merchant Marine Hearings in Washington—Future Policy Unsettled—Disposition of ex-German Ships

BY WALDON FAWCETT

WITH the approach of a date which will mark the expiration of an interval of a year and a half since the signing of the armistice, there will be occasion for the observer within the industry to be more than ever impressed with the number and variety of the proposals affecting shipping and shipbuilding which await final disposition in the Congress of the United States. If the proportions of this "backed up" mass of Congressional bills be a criterion of the popular interest in the future of the American merchant marine, there may be consolation for the deliberation which the national legislature has shown in passing upon the various suggestions before it. From the very nature of things, the offering of a multiplicity of solutions for any national problem inevitably slows down the selection of anyone.

It is befitting that in the annual review number of MARINE ENGINEERING inventory should be taken, not merely of what has been accomplished during the past month in national legislative aid of the merchant marine, but of the accomplishments of the full twelve months. Looking back over the year, one is impressed with the generous amount of deliberation and discussion that has been bestowed upon the merchant marine issue in its various angles and, by contrast, the total absence of conclusive action. The United States is today as devoid of any detailed, approved public policy on the merchant marine as it was on the day the war ended. Less understandable is the procrastination, which has held off, month after month, the determination of a policy that would permit adjustment of the claims of many shipbuilders who, acting under informal, but wholly regular contracts, contributed to the war fleet or made ready to do so.

Merchant Marine Policy Unsettled

The practical man in the shipping or shipbuilding field, impatient of "the talk" at the Capitol is apt to be especially resentful of the fact that, with all the investigation and discussion that has occurred to date, the merchant marine legislation is not yet "out of committee." That is to say, whereas one branch or the other may have approved this or that legislative proposal there is, on the main issues involved, a divergence of opinion between the United States Senate and the House of Representatives, and consequently the spring of 1920 dawned without any proposition having progressed to that stage of compromise, which must be reached ere any Act can be sent to the President for signature.

There is, however, just this consolation for the industry that, appearances to the contrary notwithstanding, no time has actually been lost by the protracted pondering of the merchant marine issues "in committee." Aside from the fact that, under Congressional procedure, the national legislature is apt to accept, in the main, the recommendations of a committee to which a given subject has been referred, and the further fact that a conscientious committee cannot intelligently make recommendations until it has carefully canvassed all angles of a subject, there was injected into the present situation the deterrent of national railroad legislation.

From the time when it became certain that the railroads of the United States were, in the spring of 1920, to be returned to private management and operation, it was manifest that railroad legislation must take precedence over merchant marine legislation. Knowledge that there would be no impulse to legislate on the merchant marine until the rail transportation situation has been disposed of has doubtless contributed to the leisurely processes of the merchant marine committees of the Senate and House of Representatives, especially the former. At that, though, it is advantageous to have the limitations of the railroad law clearly defined ere the merchant marine legislation is enacted. The two forms of transportation, rail and water, have many points of contact, actual and sentimental, and the terms of the merchant marine legislation may be made the more definite now that the railroad law has clearly indicated jurisdiction that encroaches but little upon water-borne commerce.

Disposition of German Liners

A diversion from the main issues of the merchant marine question, which had its compensations in the direction of public attention to the subject at large, was found in the flurry over the disposition of the German liners. From the standpoint of the industry, perhaps the most interesting practical outcome of the whole discussion of the sale of the ex-German ships was in the information adduced as to present valuations of ship property—estimates made in expression of the replacement prices of the tonnage under consideration. The "very large cost to recondition" (that is, to convert from troop ships to passenger vessels) also received extended attention on the part of John Barton Payne, when, as chairman of the United States Shipping Board, he held consultations with the members of the merchant marine committees of the Senate and House of Representatives.

Late in January, Chairman Payne stated to the President that it would cost possibly $40,000,000 (£8,200,000) to $50,000,000 (£10,250,000) to recondition, presumably in American shipyards, the 30 ex-German passenger ships, which had been used by the United States Army as transports. Later it was desired to obtain more specific information, and accordingly bids were sought on certain representative ships. The actual bids for reconditioning were as follows: the *Huron*, $1,919,093 (£394,000) or $178.70 (£30.5) per gross ton; *Susquehanna*, $382,000 (£78,400) or $38.50 (£7.9) per gross ton; *Callao*, $861,400 (£177,000) or $194.70 (£21.5) per gross ton; *De Kalb*, $3,815,100 (£782,500) or $433.60 (£89) per gross ton; *Moccasin*, $530,000 (£109,000) or $123 (£25.3) per gross ton; and *Æolus*, $2,279,100 (£467,500) or $223.40 (£45.8) per gross ton. It was explained that the relatively high cost on the *De Kalb* was due to the fire on that vessel, which necessitated additional work.

In consideration of whether it was preferable to recondition the ships, or allow them to pass to private ownership in their present condition, the Shipping Board caused estimates of reproduction cost to be made covering twenty of the ships. The reproduction cost, as calculated for the Board was $105,028,445 (£21,600,000). Depreciated according to the age of the respective ships at 5 percent, this left a present value on the twenty ships of $30,738,764 (£6,320,000). On the other hand, the Shipping Board

had by the latter part of February revised upward its estimate of the cost of reconditioning of the ex-German ships, placing it at $75,000,000 (£15,400,000), the expectation being that six to eight months would be required to recondition.

Commissioner Raymond B. Stevens, who alone of the membership of the Shipping Board stood out for reconditioning the ships, took the stand that just as the Board had refused the pleas of shipping men that the Government sell its cargo vessels at $100 (20/16/8) per ton, and had held out for prices of $200 (41/13/4) to $225 (46/17/6) on cargo ships, other than the old vessels, so the same policy should be followed with respect to the troop ships, namely, that of making sales only when a predetermined price could be obtained. His view has been that the sale of any tonnage, passenger ships or cargo ships, to American shipping interests at prices below the cost of reproduction is equivalent to giving a subsidy. Mr. Stevens has protested vigorously against the initial procedure of the Shipping Board, appraisers in figuring depreciation at the rate of 5 percent flat. In support of his contention he has pointed out that the Government has received bids totaling $6,810,610 (£1,400,000) on seven vessels that, under the 5 percent rule, would have no value at all. Furthermore he recalled that when, during the war, the Government was called upon to pay for ships that were lost, it settled not on the basis of 5 percent flat, but at an approximation of 2½ percent on the depreciated value. When he was asked by Congressmen whether the British do not charge off 7 percent annually for depreciation Mr. Stevens said that he never knew anybody to figure over 5 percent. Most of the shipping companies, he added, figure 5 percent depreciation a year in their operating accounts, but he interpreted that as "a margin of safety," and expressed confidence that no shipping company would figure depreciation on that basis when selling ships.

Cost of Reconditioning ex-German Ships

In the discussions at the Capitol, emphasis has been laid on the fact that the Shipping Board in calculating the cost of reconditioning had relied upon the figures submitted by professional appraisers, and that, in no instance were actual estimates obtained from shipbuilders. As indicative of possible discrepancies, Homer L. Ferguson, president of the Newport News Shipbuilding and Dry Dock Company, was quoted as figuring the reproduction cost of the *Leviathan as* $25,000,000 (£5,140,000) to $30,000,000 (£6,150,000), whereas the Shipping Board estimate gives the reproduction figure on this vessel as $20,000,000 (£4,100,000). Mr. Ferguson was further quoted, at second hand, as having stated that it would cost $450 (93/15/0) to $500 (104/3/4) per ton, right through the list, to replace the German ships, a figure that would, of course, raise the total reproduction figure far above that evolved by the Shipping Board as above outlined.

During the consideration of the merchant marine question in the Congressional committees, and especially the angle of it involving the sale of reconditioned ships, there has been extended conjecture as to the marketable value of "second-hand" ships, in the case of which reconditioning has resulted in the installation of improved equipment and fittings. This discussion was precipitated when Commissioner Stevens, countering on the argument that a "repaired" ship is not as good as one that has not been in need of repairs, said: "I do not know; it depends on how you do the repairs. We got more speed out of the *Leviathan* than the Germans ever did." Commenting on the effect of the proposed reconditioning of the vessels in the hands of the Government, Mr. Stevens said: "These boats would be practically new boats inside throughout, and have very much better power plants than they had before, which would add a considerable amount to the value of the boats." This was not convincing to Congressmen who had been told by practical shipping men that ships do actually "wear out" and that it is in recognition of that fact that it is the policy of the British to get rid of their vessels after they have seen twenty years' service.

According to information that had been given to the Shipping Board, the *Leviathan,* formerly known as the *Vaterland,* could be reconditioned in an American shipyard, but John Dever York, structural engineer of Chicago, appeared before the Senate committee on Commerce to controvert this theory. His claim was that it would be impossible to repair or recondition the *Leviathan* in any American yard, but that it would have to be done in Germany,—not in any German yard, but in the original yard,—"because it is absolutely original throughout." He arrived at this conclusion because, he said, "There is not a line of its hull—there is not a bit of its machinery, there is not a bit of its deck formation that conforms with the ordinary formations of the ships either of the British, the French or the Italian lines." Mr. York suggested that the Bremen builders be invited to come to the United States and survey the vessel. Mr. York, who claims that he had four years' experience on the Clyde, estimating as well as designing, concedes that all of the ex-German ships except the *Leviathan* could be readily reconditioned in American yards, but that the 50,000-ton vessel could not be, because it represents "new thought."

R. L. Hague, director of construction and repair of the Shipping Board, who was for a number of years engineer and naval architect in the service of one of the large shipbuilding companies on the Pacific coast, is confident that the $7,500,000 (£1,540,000) restoration job on the *Leviathan* could be satisfactorily handled in American yards. Mr. Hague has told senators that whereas this vessel could not be drydocked in this country all the work, aside from cleaning and painting, could very readily be done here. In the face of Mr. Hague's statements, Engineer York modified his former deduction that the ship could not be reconditioned in this country. As amended, his opinion was "I doubt whether we could do it properly," and he added to this the prediction that if the work was done in this country it would cost four times what it would if done in the original yard.

The trend in the marine engineering field to oil-burning equipment has been emphasized in the discussions relative to the reconditioning of the ex-German ships. In discussing the case of the *Leviathan,* Homer L. Ferguson remarked that it was "a matter of good business and design" to plan for replacement of coal by facilities for operation by oil. He pointed out that the operation of this vessel with coal had been unsatisfactory or attended with difficulty, owing to her heavy consumption of fuel. Incidentally Mr. Ferguson disclosed the fact that five different American shipyards "loaned" experts and technical engineers to co-operate in the task of preparing plans and specifications for reconditioning and fitting the *Leviathan* as an oil burner. He remarked: "It is a tremendous job, almost as big a job as designing and planning and building a ship in the first place."

As indicative of the confidence of American shipbuilders in the future of the American merchant marine, facts have recently been laid before the senate commit-

tee with respect to "adjustments," whereby representative shipbuilding firms are to proceed, on their own account, with the construction of vessels the contracts for which had been cancelled by the Shipping Board. Typical of the negotiations lately concluded was that with the Toledo Shipbuilding Company. Three of their ships were cancelled. They had cancellation claims amounting, as Chairman Payne put it, to $560,000 (£115,000) in one case and $120,000 (£24,600) or something like that in the other case." The Shipping Board, as he relates it, had made payments of $218,000 (£44,750) on account of the cancelled ships and had $161,000 (£33,100) worth of materials in the yard, representing steel fabricated for these cancelled ships. The ultimate settlement is on a basis of $600,000 (£123,000). That is, the shipbuilding company retains the money that has been paid; acquires possession of the materials on hand and receives the balance in cash. In the case of the Terry Shipbuilding Company the execution of the contract with the Shipping Board as originally entered into would require an expenditure of $4,125,000 (£847,500). Instead of that the corporation took over the unfinished ships on a basis whereby the Government is allowed $4,000,000 (£821,000) net against its contract obligations. Commenting on the disposition of shipbuilders to turn around in this wise, the Chairman of the Shipping Board said:

Adjustment of Shipbuilders' Claims

"We are making trades of this sort right along, and we find a disposition on the part of the shipbuilders to make the trade. For instance, the Northwest Steel Company, of Portland, Oregon, had a contract with us to build a certain number of cargo ships. They had a claim for cancellation of $3,000,000 (£616,000). We made a trade by which they, instead of building those ships, take a contract to build 10 tankers to be sold to a ship company, and in that way we got rid of our $3,000,000 (£616,000) loss on cancellation charges, and we helped finance the building of the shipping, and take a mortgage on the ships. The point of this is that there is a disposition on the part of the shipbuilding companies to go forward and build ships, and we are encouraging them all we can. We make no limitation as to registry. If a shipbuilding corporation wants to build ships for foreign account we help them all we can."

All the information reaching the Shipping Board is to the effect, senators have been advised, that even the corporations established during the war intend to remain in shipbuilding operations or to turn over their plants to new interests that will carry on. The case of the yard at Wilmington, N. C., has been instanced. There was consternation in local business circles at Wilmington when the Shipping Board cancelled its contracts for four vessels, but negotiations were concluded whereby the George A. Fuller Company is to build the four vessels and that corporation will, if its present intentions are adhered to, continue permanently a shipbuilding plant at Wilmington.

As has been indicated in the "progress reports" published from month to month in Marine Engineering a goodly share of the merchant marine legislative program has been devoted to discussion by authorities who have appeared at Washington, voluntarily or by invitation, to express opinions as to the conditions under which Government tonnage should be transferred to private ownership. The problem of the proper "write-off" from wartime costs has revealed an especial divergence of opinion. A very interesting aspect of the existing situation was revealed, also, to the senate committee by Charles W. Morse when, in relating that he would like to buy 100 additional ships from the Shipping Board at a price of $220 (45/16/8) per ton or thereabouts, he expressed the conviction that he could operate these ships and make money on that investment provided "the Government will not become a competitor and reduce the prices." The veteran shipping man made it clear that he was not afraid of other competitors but only of the Government. "If the Government keeps up their prices of freight," said Mr. Morse, "there is no danger in a man buying."

Terms for Sale of Government Ships

The terms of sale applicable to Government tonnage have been the subject of considerable discussion. Mr. Morse stated, at one point, that he regarded the terms now demanded as onerous. In the case of the 24 vessels which the Morse interests had contracted to build for the Government, and which, it has taken over on terms that allow the Government to get back all its costs, all its overhead and interest on its money, the conditions of payment call for 25 percent down on delivery of the ships, 12.5 percent in 6 months; 12.5 percent in twelve months; and the balance 6.25 percent every six months, allowing five years for the discharge of the obligation. However, Mr. Morse has made it clear at Washington that he could not take on the additional one hundred ships for which he has spoken on terms so stiff as the above. Instead of 25 percent down, he would like to see the down payment comparatively small, say 5 percent, and all net earnings for the first year to be applied to the purchase, with the balance spread over a reasonable number of years. Mr. Morse was inclined to endorse the tentative plan evolved by the Shipping Board, which would call for payment to the Government for vessels sold at a rate of $8.30 (1/14/7) per deadweight ton per month.

Vigorous dissent was offered by Mr. Morse to the theory repeatedly advanced before the Shipping Board that the cost of ship construction is to drop precipitately, and that even to-day, contracts can be placed in foreign yards at figures far below those that rule in the United States. He recounted an offer recently made to him by foreign interests of $185 (38/10/10) per ton to build three vessels of 9,400 tons for delivery eight months hence. As to values, his feeling is that a vessel to-day at $225 (46/17/6) a ton, is a better buy than one at $185 (38/10/10) a ton a year hence. His idea is that a shipowner may, by taking advantage of the current high freight rates, get nearly 50 percent of the cost of his vessel during the first year of operation. In other words, he would enter his second year of operation on the basis of an investment of not to exceed $125 (26/0/10) to $135 (28/2/6) per ton, and could face with equanamity the prospect of a reduction of rates in response to the functioning of the law of supply and demand after the scarcity of foreign tonnage has been relieved.

The opinion freely expressed to Congressmen by experienced shipping men that a goodly portion of the uncompleted wooden tonnage in newly established American yards ought to be "junked" or converted into barges, after engines and machinery were salvaged, has its influence upon the enactment of legislation for the adjustment and payment of the claims of wooden shipbuilders. The two branches of the national legislature have been in agreement on the basic principle that the equitable claims of the wooden shipbuilders should be granted, but there have been differences of opinion as to the precise wording of the authorization to be given to the Shipping Board.

The Present Trend of Marine Engineering

BY LIEUTENANT-COMMANDER H. G. DONALD, U. S. N.

During and since the recent war, interest in marine engineering has developed in this country to a high pitch, which is destined to be maintained. Of the benefits derived from the war, one of the most important is the impetus given to the building of a merchant marine worthy of the large volume of foreign trade of this country. Another is the unusual activity in naval construction. In this article the author gives a clean-cut, comprehensive review of the present developments and future trend in marine engineering as influenced by these conditions.

BESIDES the experience gained and the lessons taught by the war, the United States Navy has added to its fleet over two hundred and fifty destroyers in which are incorporated, despite their rapid construction, all that is latest and best in engineering to suit their needs. The building of the battleships, battle cruisers and scout cruisers, planned just before our entrance into the war, has necessarily been delayed, but is now being prosecuted. The machinery of these vessels constitutes the highest development for installations where very large powers are required, and is, therefore, of as much interest to-day as it was when it was planned. In fact, the planning and improvement of these installations were continued throughout the war and are only now nearing final settlement. The destroyers laid down by this country in such numbers to answer the Hun submarine problem are not yet all delivered, and their engineering characteristics are up to the minute for very light weight, high powered requirements.

The War Creates a Merchant Marine

The American merchant marine as it stands to-day is purely a product of the war. The majority of the vessels were built for the Emergency Fleet Corporation. Due to the necessity for quantity production of cargo carriers on a large scale, the standard ship was evolved. If it had been possible in this country, as it was in Great Britain where the shipbuilding industry was so well developed, the regulation merchant vessel equipment of triple expansion, recriprocating engines and Scotch boilers would have been installed in practically all ships. As it was, although all facilities for the manufacture of the regulation engines and boilers were used, and the Government contracted for shops and even whole plants for the manufacture of Scotch boilers, still the demand far exceeded the supply and the old standard installations were supplemented by large and small tube watertube boilers, geared turbines and internal combustion engines. Thus there were adopted for merchant use, machinery and boilers which in the ordinary course of events would not have come into general use for several years.

The merchant sea-going engineer is loath to take up "new-fangled" ideas. It is only natural that he should be more averse to them than his brother ashore who can obtain the advice of experts or the services of the manufacturer's repair men by sending a telegram or using a telephone. In a ship, when she leaves the dock, the engineer must be sure of his machinery; for he is entirely independent of outside assistance, and, in addition, there are the perils of bad weather should a mishap occur. The wireless telegraph has done a great deal to allay these apprehensions.

The personnel situation in the merchant marine, particularly in regard to engineers, is a very serious one even now. The inability of personnel of little experience to operate the newer types of machinery has caused much destructive criticism where it was not deserved. While the failure of a new type of machinery is spread broadcast, that of the old is not considered to be of sufficien importance or interest to warrant discussion, and it is not generally heard of. But it may be safely stated that there have been as many casualties with the older types of machinery as there have been with the newer ones. One point in regard to inexperienced personnel that is worth bringing out is that this same inexperience and newness to marine engineering will make the operating engineers more receptive of the more advanced ideas than would engineers that had been brought up at sea.

The increasing cost of fuel is compelling shipowners to seek for and to adopt any improvements in machinery installations that will give economy, providing reliability is established. The recent development of marine machinery has been along the lines of securing greater efficiency of the unit and greater economy in overall operation. There are some who will say that a number of the late improvements have still to prove their reliability. Recent development has not been in the nature of making machinery more complicated, but just the reverse, and it can be stated from personal experience that the operation and upkeep of a highly modern installation is a much easier task than that of caring for one of the same power, built along the lines in practice ten years ago.

Machinery for Main Propulsion

The various types of machinery in use to-day for main propulsion are as follows: Reciprocating steam engines, turbines, direct connected; turbines, with mechanical single or double reduction gears connecting them to the propeller shafting; turbines, driving electric generators which in turn supply current for turning motors connected to the propeller shafting, either direct or through mechanical reduction gears; internal combustion engines connected to the propellers direct or through mechanical or electrical reduction.

The Reciprocating Steam Engine

The reciprocating steam engine is the old standard propulsive machinery for merchant vessels of the cargo type. This engine has been developed to what may be considered its maximum efficiency. For slow ship speeds and low powers it has much to recommend it from its reliability. The usual type is triple expansion, three-cylinder vertical, inverted cylinders. Quadruple expansion is also in use. One of this type is that found in specifications for the latest Shipping Board cargo vessels of 10,000, 12,000 and 15,000 deadweight tons. The engines to be used are quadruple expansion, four-cylinder, using the Yarrow-Schlick-Tweedy system of locating crank angles for balancing. An economical figure of .83 pound of fuel oil per indicated horsepower-hour is claimed. The modern naval reciprocating engine is triple expansion, four-cylinder (two low-pressure cylinders), arranged in

the order of forward low pressure, high pressure, intermdiate pressure and after low pressure, and fitted with forced lubrication for all bearings including valve gear. In general use to-day are the Stephenson link gear, piston valves on the high pressure and intermediate pressure cylinders, and balanced double-ported slide valves on the low-pressure cylinders (piston valves in the Navy), straight, short ports giving minimum cylinder clearances and the lowest possible steam velocities. The strokes used for slow speed cargo vessels are: 36 to 40 inches for engines of 1,000 to 1,250 indicated horsepower, 40 to 48 inches for engines of 1,300 to 1,800, and 48, 54 to 60 inches for larger sizes. The revolutions per minute with reciprocating steam engines for ship speeds of 9 to 12 knots are 90 for indicated horsepowers up to 3,000 and 80 down to 65 for indicated horsepowers of 3,000 and up.

Without question, the navies of the world have been the clearing houses for the development or rejection of new ideas in marine machinery, and this is one of the important peace-time functions of the United States Navy. Not only are various inventions and improvements given a trial under conditions where the operators are above the standard of the merchant operating personnel, and where their true worth is demonstrated beyond a doubt, but also the necessary encouragement is given the machinery manufacturers of the country under conditions simulating government subsidy. The Government itself does a great deal of experimental and research work which has helped the art of marine engineering. Of course, there are certain conditions for which naval machinery must be designed which are not met with in merchant practice, notably, design to provide for economy at low power (cruising speed), and duplication of units, but, in general, the most up-to-date naval practice may properly be considered to be the future trend of merchant vessel machinery. It is hardly likely that any types of propulsive or auxiliary machinery or boilers will be introduced into the merchant service which have not first been proven to be successful in the Navy from the standpoint of both economy and reliability.

Development of the Steam Turbine

In 1905, the Navy Department determined to try the turbine for marine propulsion. Three scout cruisers were authorized, one to have reciprocating steam engines on two shafts, one to have Curtis turbines on two shafts, and one to have Parsons turbines on four shafts, all using direct drive of the propeller. On trial of these vessels, the reciprocating engine showed up to better advantage than either turbine. However, the results obtained and subsequent improvements in design warranted further trial of the turbine in other vessels.

During the tests of the next few years it still appeared that the reciprocating engine was better suited than the turbine for marine use. This was because the designers of the turbine lost sight of economy of propulsion and aimed only at securing economy of the turbine. A number of methods of securing economy of the turbine at cruising speed were developed, including extra turbines for use at low power only and a combination of turbine and reciprocating engine. These methods prevailed until the development of reduction gears.

By the introduction of such gears, whereby the turbine speed could be kept high at all speeds of the vessel and the propeller speed kept low, large increases in the economy of propulsion resulted, with the further result that the turbine firmly established itself in favor. This discussion applies to cargo vessels as well, for it must be remembered that the cruising speed mentioned is around twelve knots.

This variation of turbine and propeller speed has been accomplished in two ways—by mechanical reduction using helical gears and by electric reduction having the turbine drive a generator which drives electrically a motor on the propeller shaft. The first trial of the mechanical reduction gear in the United States Navy occurred in 1910, and the trial of the electric drive was in 1911, the ships used being naval colliers. Both of these trials were highly successful; and although there have been a number of direct-connected turbine installations put into naval vessels since that time, this method of drive is now no longer considered. The few destroyers built during the war at Newport News with direct drive of main turbines and geared cruising units were only allowed because of the difficulty of securing the gears for the main turbines; all of the remainder of the destroyers built during this time have geared main turbines.

Reduction Gears

In the naval service, it is now standard to use mechanical or electrical reduction on all vessels that are to be operated by a naval crew. Electrical reduction is used only for capital ships, i. e., battleships and battle cruisers. Both the reliability and the economy of the turbine have been established from a naval point of view. Geared turbine drive on destroyers has raised the economy of propulsion at cruising speeds over 30 percent, and in larger vessels the saving, while not so great, is a very substantial figure.

The 20,000-ton, 28,000 shaft horsepower battleship *North Dakota* is an interesting case where the main turbines have been of both types. The original turbines were direct drive, installed in 1910, and were replaced in 1918 by mechanical-geared turbines, one high pressure and one low pressure on each shaft. It is stated in the last annual report of the chief of the Bureau of Steam Engineering that the gain in economy of propulsion effected has amounted to 31 percent at practically all speeds.

If it were not for the turbine itself, such high powers as are in use or contemplated on battleships, battle cruisers, scout scruisers and destroyers would be out of the question. For example, the powers to be used and in use in our latest high speed warships are as follows: Destroyers (35 knots), 28,000 shaft horsepower; battleships (23 knots), 60,000 shaft horsepower; scout cruisers (35 knots), 90,000 shaft horsepower; battle cruisers (34 knots), 180,000 shaft horsepower. Truly these are stupendous and almost unbelievable figures, if viewed with the light of five years ago. Speeds as high as 39.7 knots (H. M. S. *Tryon*) have been obtained with turbine installations in destroyers. As high as 25,000 horsepower per shaft, and 15,000 horsepower per pinion are now in use.

Efficiency of Mechanical Reduction Gears

The efficiency of the mechanical reduction gear has been the subject of much discussion, but, with good design, a figure of 98½ percent for single reduction and 97 percent for double reduction gears at full power seems safe. The angle of the teeth has been reduced from 45 degrees to 30 degrees in a number of recent designs and a small

pitch appears to be preferable to a large one, provided the tooth pressure is not allowed to go too high. In general, gears have been satisfactory in service, and cases of failure can all be traced to hurried manufacture, defective material or carelessness in operation. Pitting of the teeth, due to excessive local pressure causing spots of small diameter to flake off, has not affected the working or the life of the gears. The most successful gear manufacturers use horizontal machines for cutting gears and some have an attachment for causing the table to creep, thereby discounting any small error in cutting which would otherwise produce objectionable vibration and noise when the gear is in use.

Not only has the geared turbine proved to be an unqualified success in naval vessels, but also it has been taken up extensively for the propelling machinery of merchant vessels of both cargo and passenger types. Once its reliability is established beyond a doubt when operated by a merchant crew, it will be the only design considered where steam is to be employed, with the possible exception of turbo-electric drive, and where the prospective operating personnel is of a low order. Of all the vessels operated by the Shipping Board, 40 percent are geared turbine drive.

Troubles With Geared Turbines

It is reported that a great deal of trouble has been experienced with the gears of these vessels, and it is because of this that the Shipping Board in its latest vessels is considering only the quadruple expansion, reciprocating steam engine. In all fairness to the gear manufacturers, it must be stated that these troubles were due either to the hurried manufacture of the gears under stress of war conditions, demanding the full capacity possible of the shops, or were due to the inexperience of the operating engineers, who probably would have come to grief with reciprocating engines.

Lubricating Systems

A material aid to the successful operation of the geared turbines on merchant ships is the new arrangement of the lubricating system being introduced into these vessels, and troubles undoubtedly will be less frequent when it is adopted on all geared turbine ships operated by merchant crews. Lubrication of the main propelling plant is a very important item in any system, but it is of paramount importance in turbine drive, whether direct or geared. The choice of lubricating oil is well handled by the large lubricating oil companies, and, for the merchant service a ship is hardly likely to get the wrong kind of oil for the type of engine installed.

The system of lubrication originally installed on merchant ships has not proved altogether satisfactory, and the failure of many geared turbine installations has been due to this fact. In the naval service, it is standard practice to supply the lubricating oil by duplicate pumps under pressure direct to the bearings and gears. This method has proved a most satisfactory one, and there are few cases of failure of the system. In the merchant service it has been found necessary to install tanks of a considerable capacity at a height above the engines that will insure a proper pressure on the system to the bearings, 20 feet, or about 10 pounds being considered a minimum figure. The tanks are fed by the forced lubricating oil pumps and an alarm (float type, electric) is fitted on the tank to give due warning when the supply is getting low.

For merchant practice, two methods of installing the pumps have been used; one, with the pumps driven from the main shaft, and, the other, with pumps having independent drive, which are provided in duplicate. Strainers in the oil discharge piping are always installed, and, in naval practice, in the suction piping also. The application of the centrifugal separator, first used for the separation of cream from milk, for the renovation of lubricating oil marks, really, a great advance in lubrication and eliminates many of the troubles that appear only in marine installations

The separator removes from the oil both water and sediment in a most efficient and expeditious manner, even when salt water has formed an emulsion with the oil, and delivers the oil in the same state as when new. These separators are being installed by the Navy wherever forced lubrication is used. When used properly and regularly, they safeguard the bearings by making it possible to keep the oil continuously in good condition, and there is no reason why, with due care, the bearings should show any appreciable wear even after years of service.

The money value in oil saved has made their installation in naval vessels well worth while. The method in general use of settling out sediment and water by heating the oil in settling tanks is not nearly so satisfactory in that the separation of the impurities from the oil is not complete, the time for settling with any results at all is comparatively very long, and the tanks required are cumbersome.

The single reduction gear is in use where the ship speed is above about 14 knots. For speeds below that, the double-reduction gear is usually found. The average cargo ship recently built has a propeller speed of 90 revolutions per minute for geared-turbine drive.

Balance of Turbines, Gears and Propellers

When using high-turbine speeds, as in reduction geared installations, the matter of securing a good degree of both static and dynamic balance is of much importance. This matter has been taken up by the Navy at a recent date, and although only a few installations have been scientifically balanced, the necessity for it is recognized, and it will become standard practice. The most successful balancing has been done by the Mare Island and New York Navy Yards, where not only are the turbine rotors balanced, but also the pinions, main gears, shafting and propellers. The perfection of balance obtained has been such that when the turbines are driven at 20 percent over speed (with propeller shafts disconnected), the vibration is so small as not to shake down coins standing on edge on the bearing-cap bolts. Destroyer geared turbines which have been balanced show an increase in efficiency over those which are not, while the vibration of the hulls becomes reduced to a neglible minimum. Proper balancing also has a marked effect on reducing repairs to the turbines.

Thrust Bearings

In connection with the geared turbine, due credit must be given to the Kingsbury thrust bearing in this country, and to the Michell thrust in Great Britain. This type of bearing makes possible the use of a single collar. It gives a decided improvement in the mechanical efficiency, saves space and weight and gives economy of lubricating oil. It is suitable for use with any type of propulsion. While it has not by any means come into general use in the merchant service of this country, there are a few vessels in which it has been installed. The reason for it not being adopted on a large scale is the same reason that holds back the geared turbine, i. e. lubrication—oil must be supplied continuously. In the naval service, it has become the standard thrust bearing with the building of the *Tennessee* class of battleships. All destroyers built during the war are fitted with it, and, in fact, had it not been available, serious difficulty would have been met with

in finding sufficient space for the old horseshoe type. The General Electric turbines supplied to the Navy have used their type of single-collar roller thrust bearing on the turbines themselves.

The bearing pressures used in the Navy for the horseshoe thrust were from 62 to 74 pounds per square inch, whereas, with the Kingsbury, the thrust pressures run from 291.5 to 425 pounds per square inch. The 425 figure, is found on the new turbine installation of the *North Dakota*, where these bearings have been particularly successful.

Hydraulic reduction gear is in use on some German ships (Föttinger type), and has also been tried experimentally in the British Navy. It is not used in this country in either the merchant marine or navy.

Types of Turbines

The two general types of turbines in use are the Parsons and the Curtis, with modifications of both. In America, the Curtis is found in more installations than is the Parsons, both in the navy and in the merchant service. However, the Parsons installations in the Navy have all been most successful, and the more general use of the Curtis is rather a question of its having been developed on a larger scale by the manufacturers in this country than has the Parsons. The design of blading and particularly the method of securing blades in the rotor have been much improved. In England it is usual to find the Parsons turbines that have recently been built fitted with an impulse type of first stage, in order to reduce complications due to very short first-stage blades, and consequent high percentage of leakage past the blades.

Electric Drive

Another method of obtaining both high propulsive efficiency and high turbine efficiency at the same time is the reduction by means of electricity of the speed of the propeller below that of the turbine shaft. This system of propulsion offers such great advantages in the matter of location of the machinery to obtain maximum protection from damage due to underwater attack that it has recently been adopted by the Navy as the standard for capital ships, i. e. battleships and battle cruisers. The engineering features have been well developed by both the General Electric and the Westinghouse companies, and this country is much farther advanced than any other in knowledge of the details of design and manufacture connected with such installations.

So far, the only cargo vessel in America on which it has been installed is the *Jupiter*. This vessel was the one selected by the Navy for the demonstration of electric propulsion, and the result of about six years' service has demonstrated the reliability of the system beyond a doubt. It was after the successful test of the *Jupiter* that the design was adopted for the *New Mexico* and later for twelve battleships and six battle cruisers now building. At present the Navy does not contemplate the installation of electric drive on any vessels except capital ships.

The Coast Guard Service is placing this drive in two of the five 1,600-ton, 2,600 shaft horsepower cutters now building, the other three ships to have mechanical-geared turbine drive.

In England, electric drive has not received much attention, although one merchant vessel is so fitted. On the British *K*-class submarines, it has been adopted for use immediately after coming to the surface or just before submerging, the motors being driven at this time by Diesel engines. When operating normally on the surface steam turbines are used and when submerged, of course, the motors are operated by batteries. In Sweden, seven vessels are being fitted with Lungström turbo-electric drive; two are of 1700 horsepower, and five of 1200 horsepower.

It is understood that the Shipping Board is considering installing electric drive on some of its cargo vessels. For merchant service, the Diesel electric drive is looked upon by some with more favor than the turbo-electric combination. An interesting recent installation of this character is on a trawler just put in service on the New England coast.

Advantages of Electric Drive

The merits of the electric-drive system as applied to naval capital ships are well stated by Admiral C. W. Dyson, chief of the design division of the Bureau of Steam Engineering, Navy Department, in the May, 1917, issue of the *Journal of American Society of Naval Engineers*. It will be seen that many of the advantages stated apply as well to merchant vessels.

1. Greatly increased torpedo protection for ships.
2. Greater flexibility in machinery arrangement.
3. Better and wider separation of important units.
4. Minimum lengths and diameters of steam pipes.
5. Reduced heating of vessel from steam pipes.
6. Better centralization of power.
7. Fewer bulkheads pierced by steam and feed piping.
8. Reduced engine room complement.
9. Elimination of danger from fractures of piping due to shells striking protective deck.
10. Greater ease in control.
11. Greater flexibility in power distribution.
12. Better maintenance of economy through a wide range of powers.
13. No metallic contact between rotor and stator of motor.
14. Eliminates all dangers of disarrangement due to shaft vibration, when the helm is put hard over.
15. Maximum reduction in length of shafting.
16. Increased backing power.

The internal combustion engine for ship propulsion has not received the stimulus that it deserves in this country. The Shipping Board has two vessels in service equipped with Diesels, one a 4,500 indicated horsepower Burmeister and Wain and, the other, a 3,000 indicated horsepower McIntosh and Seynour installation. It has been proposed by the Shipping Board to install this type of engine in ten other vessels.

Motorships

Very few vessels are equipped with internal combustion engines of over 1,000 horsepower per set. However, that there is some and increasing interest taken in this country in the Diesel engine for marine propulsion is shown by the fact that most of the large shipbuilding companies are obtaining licenses to manufacture foreign designs and a few are developing engines of their own design. The war caused a setback in the development of the Diesel for commercial work, which will make it more difficult for it to catch up with the geared turbine. Considerable experience was, however, gained during the war in the building of heavy oil engines for submarine work, and undoubtedly, the high cost of fuel will force it to the front in considering types of propulsion of future cargo ships.

Propellers

The form of the propeller in use to-day is the same that has been in use for years, that is, the true screw is still considered to be the proper form and the many inventions and attempts to improve on it have come to

nothing. However, the method of preliminary determination of pitch, diameter and projected area has been so improved that predicted performance checks up very accurately with actual results where the form of hull is known in advance.

Boilers

The main features in boiler development for marine use have been the introduction of the watertube boiler into merchant ship work, the great extension in the use of fuel oil in place of coal and the development of the small-tube boiler of very high capacity for naval purposes.

Upon the entrance of the United States into the recent war, when the construction of merchant vessels was taken up by the Government on such a large scale, it was impossible to secure a sufficient number of the standard marine Scotch (or firetube) boilers, and it became necessary to call on manufacturers of watertube boilers to outfit many of the new vessels. As a result, of the total number of boilers in the Emergency Fleet about 56 percent are watertube and about 44 percent are firetube. The watertube boiler is forcing recognition as the superior type for merchant work, and one hears more and more of its merits. This is especially true where oil fuel is used and where pressures over 200 pounds gage are necessary. However, the specifications for new cargo vessels recently issued by the Shipping Board call for the boilers to be single-ended Scotch, steam pressure, 220 pounds gage, 100 degrees F. superheat and oil-fired.

A large number of types of watertube boilers are found in recently constructed merchant vessels, and the type in most general use is the Babcock and Wilcox, with the Emergency Fleet boiler a close second. The customary evaporating rate used in merchant work is 5 pounds steam per square foot heating surface for both watertube and firetube boilers, whether oil- or coal-fired.

Mechanical stoker firing of watertube boilers has received practically no encouragement, although there is no apparent reason why some of the designs which have met with such success ashore should not be developed for marine purposes. The Navy has not attempted to develop it because of failure of existing designs to stand up when the vessel is rolling, because of the sudden and frequent variations in load required when ships are steaming in formation, and because of the adoption of oil as fuel. The use of mechanical stokers on merchant ships will probably come when the price of coal drops, for the advantages of mechanical stoker firing are many where the load is constant hour after hour, and where the firemen are more apt to be inefficient.

Naval Boilers

In the naval service the large tube watertube boiler is the standard for all installations except where, on account of limited space or weight requirements, the use of the small-tube express-type boiler is mandatory, and in auxiliary vessels which have merchant crews where Scotch boilers are still installed in a few cases.

Upon the adoption of oil fuel for naval boilers, the Babcock and Wilcox Company, in order to meet the demands of the Navy, modified their boilers as follows: The side-water walls were eliminated, heavy fire brick walls being substituted; the angles of the tubes and headers were changed, tubes from 15 degrees to 18 and 20 degrees and headers accordingly; outside downcomers were installed between the steam drum and the lower front crossbox; the lower row of 4-inch tubes was done away with and two rows of 2-inch tubes substituted. At a very recent date it was found necessary to modify the baffle in the steam drum in order to prevent priming at very high rates of steaming for this type of boiler.

In addition to the new express boiler designed by Admiral Dyson, which is made mention of later, improvements have been made in an express boiler of the White-Forster type, fitted with superheater. On test at the fuel-oil testing plant at Philadelphia in May, 1919, this boiler (total heating surface 8,353 square feet) obtained an evaporation of approximately 23 pounds of water from and at 212 degrees F. per square foot of heating surface with an equivalent evaporation of 15.3 pounds of water per pound of fuel oil. This is a record high capacity performance. It is of much value in that it proves that the express-type boiler may be forced, without danger, to a much higher capacity than was formerly thought possible. In the battle cruisers, scout cruisers and latest type of battleship where very high powers are used, adherence to former practice would have made the boiler weights prohibitive.

Forced Draft

Forced draft is becoming more general in merchant ship boiler installations, whether using oil or coal fuel. The air pressure is 2 inches of water regardless of the fuel. For coal, the Howden closed-ash-pit system is used and for oil the air is supplied by ducts led to each individual burner. In the naval service, a pressure of 2 inches of water is used for coal and 6 to 9 inches for oil. Eight inches has been recently adopted as the standard pressure for capital ships in order to prevent flare back of oil flame into the fire room due to the blast down the smoke pipe from heavy gunfire. On the new 35-knot destroyers, one often sees as much as 9 inches air pressure in the fire rooms when the boilers are driven at full power. Naval practice has always been to use the closed-fire-room system of forced draft, and this will undoubtedly be adhered to in the future on account of safety and comfort, although the air leakage is in design estimated at 50 percent notwithstanding the great care in construction given to secure air tightness of compartments. In the latest capital ships, this figure is probably too high, for each boiler is in an individual compartment and the only access is through a well-constructed air lock.

Steam pressures have not been materially increased. In the naval service, the tendency has been, if anything, toward a slight reduction in pressure. In the merchant service it is, however, now common to use pressures of from 200 to 250 pounds gage, about 220 pounds being the usual figure. Of course, when watertube boilers are installed the pressure is apt to be higher than when firetube boilers are called for.

Superheated Steam

The use of superheat is becoming recognized to be well worth while from the material increase in economy that is realized, and an increase in the amount of heat per pound of steam available for useful work is being obtained by superheat rather than by increase of pressure. In the Navy, superheat was introduced in recent years in the *Michigan* class of battleships and continued into the *Delaware* class only to be dropped, on account of the use of Parsons turbines, and then to be taken up again in the new battleships and battle cruisers now building.

In the battle cruisers particularly, where it was necessary to install an express-type (small tube, large angle of inclination to the horizontal) boiler, and as there was only one boiler of this character on the market to which superheaters were adaptable, the Bureau of Steam Engineering designed a boiler especially for the purpose. This

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boiler was brought out by Admiral Dyson, and the particular feature of design is that the superheater is nested in the generating tubes, but in such a manner that it can be rolled out for the renewal or inspection of tubes.

Superheats of 100 degrees F. are common in this country. In England the tendency is to use 200 degrees. All of the later Shipping Board merchant ships are fitted with superheaters. This applies for both turbine and reciprocating engines, watertube and firetube boilers. The Shipping Board prefers the waste-gas type superheater for watertube boilers, while the Navy installs the superheater at the end of the first gas passage in a baffled watertube boiler. In firetube boilers the most favored superheater consists of tubes laid within the upper rows of generating tubes.

Fuel Oil Burning

Fuel oil may now be taken as being the standard fuel for the Navy for all types of vessels. In the merchant service fuel oil is most popular, as is indicated by a survey of the ships operated by the Shipping Board, where of those fitted with reciprocating engines 70 percent burn fuel oil and of the turbine ships 55 percent use this fuel. Some interesting figures in this connection are the standard fuel allowances per horsepower-hour for the various types of ships in the Emergency Fleet. These figures are used for checking fuel requisitions and the performance of vessels.

Type Engine	*Fuel Used*	*Standard Fuel Allowance in Pounds Horsepower Hour*
Reciprocating	Coal	2.41
	Oil	1.25
Turbine, geared	Coal	2.0
	Oil	1.0
Diesels	Oil*	.39

*Includes 150 horsepower boiler in use for steam heating.

Important points in the development of fuel oil burning in the Navy are as follows: The superiority of the Bureau of Steam Engineering and the Peabody types of registers and atomizers has been demonstrated beyond a doubt by test and service use. The Bureau register may be used for either forced or natural draft.

A large variety of types of registers and atomizers are in use in American merchant ships. The Shipping Board vessels alone have fifteen types installed and the tendency there is to use natural draft burners. The new naval general machinery specifications provide that the center of the register must be 22 inches from tubes or sides or bottom of furnace. Specifications for latest naval capital ships make provision for a maximum of 10.8 pounds of oil to be burned per cubic foot of furnace volume. The matter of having a sufficiency of furnace volume has been found to be one of utmost importance if good combustion is to be obtained.

Auxiliary Machinery

Improvements in the design of auxiliary machinery have kept pace with the advance of main propulsive machinery.

Condensers

The standard style of condenser that has been in use for years is still the rule. However, a number of modifications have recently come into use. The cross section is either circular or pear-shaped. Merchant practice uses straight ¾-inch tubes packed at both ends, naval practice uses straight ⅝-inch tubes expanded into the tube sheet at the entering-water end and packed at the other, or curved ⅝-inch tubes (destroyers) expanded at both ends. Two passes of the circulating water are the rule in merchant and naval ships except destroyers and scouts which use one pass. In merchant practice the water enters at the top in some and at the bottom in others. Latest merchant ships are provided with two injections, one high for use in shoal, smooth water, and one low for use at sea. On all the lake steamers that were brought to the seaboard for use in trans-oceanic service it was necessary to fit a low injection as the one installed rolled out of water when the ship was in a seaway.

Naval two-pass condensers recently constructed have spherical heads. It was found that the flat head gave too little area for change of direction of flow of water at the reversing end. In the latest naval condensers the cooling surface per horsepower has been decreased and circulating water considerably increased.

The only departure worthy of mention from the standard arrangement of tubes and steam flow is the Lovekin patent condenser. This is a special design with tubes and steam space baffling so arranged as to provide, by use of drip sheds, for a minimum loss of effective cooling surface by drowning of the lower tubes from condensed steam dripping from the upper tubes and to provide for a central vertical chamber in the tube nest from which the air ejector takes suction, the chamber being open to radiating passages which draw from all parts of the lower half of the condenser. This type of condenser is being installed in the battleships *Tennessee, California, Colorado* and *Washington*. It is also to be used in twelve Army transports building at Hog Island. One of the latter vessels is now testing the condenser. It is expected that the vacuum desired will be obtained with a considerable reduction in cooling surface and circulating water over the old type without special baffling in the steam space. Also it is expected that the vacuum obtained at the top of the condenser will more nearly equal that at the air ejector suction.

Pumps

For air pumps the Edwards type is still the favorite in the merchant service for both turbines and reciprocating engines and for the latter is operated by the engine. There are, however, a few installations of the air ejector—condensate pump type for turbine installations. This latter system is the only one considered for the latest capital ships of the Navy, both on account of the great saving in space and weight and also on account of the ease with which a high vacuum may be maintained.

The augmenter type of ejector discharging into a special condenser connected to the suction of a reciprocating air pump has been, in some cases, displaced by the two-stage ejector, discharging to an air separating space in or above the main feed and filter tank. In this type, all heat in the steam used for operating the ejector may be reclaimed in the feed water. Inter-condensers are sometimes installed between the first and second stages of the ejector in order to reduce the steam consumption, but they are not necessary if the heat in the steam used does not raise the temperature of the feed water to too high a degree.

Feed Pumps

Merchant ships are using vertical, simplex, double-acting type feed pumps, independent of the main engine. In naval practice the same type is used for auxiliary feed purposes, but for the main feed turbine driven centrifugal pumps are being installed on large vessels.

In naval service the centrifugal pump, either steam or motor driven, is coming into use wherever this type of pump is practicable. The Bureau of Steam Engineering, Navy Department, has given a great deal of careful study

to the question of speed control for turbine-driven auxiliaries supplemented by actual tests and experiments on board vessels of the fleet, with the result that satisfactory governing devices have been selected.

In the merchant service, pumps, except main air, feed and circulating, are nsually of the horizontal, duplex, double-acting type, but even here the centrifugal turbine or motor-driven pump is coming into use and is found in not a few new turbine-driven ships.

On motorships, motor-driven pumps, and in fact motor-driven auxiliaries of all types are the rule.

Forced Draft Blowers

The turbine-driven blower is the standard for naval vessels when forced draft is installed. This has replaced the motor-driven blower principally on account of its greater range of and better elasticity of speed control, and the fact that it is independent of the ship's generators.

Merchant ship blowers are usually driven by reciprocating engines; there is a tendency, however, to install motor drive.

Feed Water Heaters

Feed-water heaters are now always installed on naval vessels. The type is the closed heater on the discharge side of feed pumps. Straight, "U" and coiled-tube types are used. The specifications have recently been changed to provide for a capacity 25 percent greater than is necessary to obtain the required feed temperature at full power and drain of such size as to handle twice the condensed steam expected. For feed-heating reasons, the pressure on the auxiliary exhaust system is carried at a standard of 10 pounds gage, and steam not condensed by the feed heaters is spilled into the main engines, with an emergency relief to condenser.

Feed heaters are being installed in the most up-to-date merchant vessels, the installation being similar to naval practice except that the pressure carried on the auxiliary exhaust system is 5 instead of 10 pounds gage.

Evaporating (Distilling) Plants

These have recently received a great deal of attention and improvement in the Navy. The low capacity (25 gallons per day per square foot heating surface), horizontal straight-tube type has been abandoned for the high capacity per square foot heating surface, vertical coiled or "U" tube types. The latter type of evaporator has been developed to a remarkable degree and capacities of 120 gallons per square foot heating surface per day have been made. Naval practice now limits this to 60 gallons per day per square foot heating surface, except on destroyers, where as high a figure as 80 is allowed.

On naval vessels it is usual to install evaporators for operating on live steam using the double-effect system. Latest installations allow for the use of auxiliary exhaust in coils, the evaporators being operated single effect and an air pump being provided for maintaining about 20 inches of vacuum on the distilling condensers. This has proved to be an installation producing great economy.

Low Pressure Distilling Plants

It is not customary to use more than double-effect operation, but an exception to this is the interesting installation in the battleships *Tennessee* and *California* to be commissioned in the near future. With the exception of the installation in the *Dixie* these are the only all low pressure distilling plants in the Navy. Six evaporators are installed and piped up so that they may be operated in single, double, triple, quadruple or sextuple effect. Live steam may be admitted to first effects and auxiliary exhaust may be admitted to first effects for single effect operation or to the second effect in multiple effect operation.

The daily capacity of naval distilling plants has been materially increased, destroyers from 5,400 gallons to 10,500 gallons in latest boats and on battleships from 25,000 gallons on the *Pennsylvania* class to 50,000 gallons on the 49-54 class (60,000 shaft horsepower), and 70,000 gallons on battle cruisers 1 to 6 (180,000 shaft horsepower). An allowance of 10 gallons per man per day is considered with the Navy a liberal allowance for all purposes except for engineering department, and in the engineering department on large vessls an approximate figure for making up feed expenditure is 1,800 at anchor, and 4,200 under way at 12 knots (varying from this with the power required). These are not design figures.

Practically all merchant ships recently built have evaporating plants of considerable capacity installed. The capacity is now such that the vessel may, if desired, distill all of the water for both deck and engineering purposes.

Refrigerating Plant

On merchant ships built during the past few years, a refrigerating plant of ample capacity is always found in almost all cases. On cargo ships this is about two tons per 24 hours. Ammonia compression, ethyl chloride, CO_2 and SO_2 systems are the rule with preference for SO_2 in the Shipping Board vessels. Steam drive is being displaced by motor drive. The dense air system has until recently held the field in the Navy. CO_2 systems are now installed on practically all new ships, except destroyers where ethyl chloride and SO_2 systems are found with a few of the CO_2 type. Naval refrigerating apparatus of whatever type is turning to motor drive especially for small-size systems of two tons and under.

Electrical Plant

Aboard ship electricity is being put to more and more purposes and the electrical plant is a most important part of the installation. The geared turbo-driven generator is the naval practice, while the reciprocating steam engine-driven generator is found in most common use on steam merchant vessels, with turbo drive on a few. Ships with internal combustion engines for main propulsion commonly use the same type of engine for generators.

The sets are now installed in duplicate on merchant ships, this having always been the naval practice. It is believed that the introduction by the Navy of interior communication on commercial vessels during the war will have a lasting effect in that the need of the telephone, call bell, and electrical indicator for various purposes will be felt by merchant ship captains. The electric motor-driven pump which is being taken up on these vessels will also mean an extension of the electrical plant. Radio installations on merchant ships are now looked upon as a necessity.

Conclusion

In summing up the situation, one need not be a born optimist to feel that tremendous strides have been made in the general improvement of engineering at sea, and that future developments as indicated by conditions today will be most interesting.

The ninth annual banquet of the Delaware River Branch of the American Society of Marine Draftsmen was held at the Hotel Adelphia, Philadelphia, Pa., on February 27, with about 350 members and guests present. A. H. Haag, president of the society, presided.

Machining and Erecting Marine Engines

BY WILLIAM WYLDE* AND R. M. SHERMAN†

Considering the long periods of constant running, and, at times, the extraordinary conditions to be met and overcome, it is of prime importance that the marine engine should be designed and built by, or under the strict supervision of, men trained for that purpose. Each unit should be machined accurately, and, when assembled, should have such clearances for working fits as have proved by actual experience to give the minimum friction and the maximum service. This article tells how such work is carried out in the shops of the Newport News Shipbuilding and Dry Dock Company, Newport News, Va.

THE engine, the construction of which is described in this article, is of the vertical, quadruple expansion type with cylinders 24 inches, 35 inches, 51 inches, and 75 inches in diameter, by 51-inch stroke, fitted with Stephenson link-valve gear and designed for 2,600 indicated horsepower, at 70 revolutions per minute. The working boiler pressure is 220 pounds gage. The high pressure and the first intermediate-pressure valves are of the piston type, and the second intermediate, and the low-pressure valves are of the double-ported slide type. Balance cylinders are fitted for the valves of the first and second intermediate-pressure and the low-pressure cylinders. An Aspinall marine governor is fitted.

The crank shaft is of the built-up type in four interchangeable sections. The bedplate is cast iron, of the box-girder type, in four sections. The cylinders are cast iron, the two intermediate-pressure and the low-pressure cylinders are bolted together, and the high-pressure cylinder is secured to the others by means of rugged tie rods. Cast-iron liners are fitted in all the cylinders except the low pressure. The high-pressure and the first intermediate-pressure pistons are cast iron and the second intermediate pressure, and the low pressure are cast steel.

The arrangement of cylinders, beginning at the forward end, is high pressure, low pressure, second intermediate pressure and first intermediate pressure. The columns are cast iron of box section with ahead and backing guides bolted on each. Receiver pipes from the high pressure to the first intermediate-pressure cylinders are of copper and the receivers for the other cylinders are integral with the cylinders. The piston rings overrun ¼ inch at the top and 0 inch at the bottom.

The operating gear is on the starboard side of the engine. A small double-cylinder turning engine is bolted to the back housing of the first intermediate-pressure cylinder. A single-cylinder reversing engine is bolted to the back housing of the second intermediate-pressure cylinder. An efficient lubricating system is connected to all bearings, and water service is led to the main bearings.

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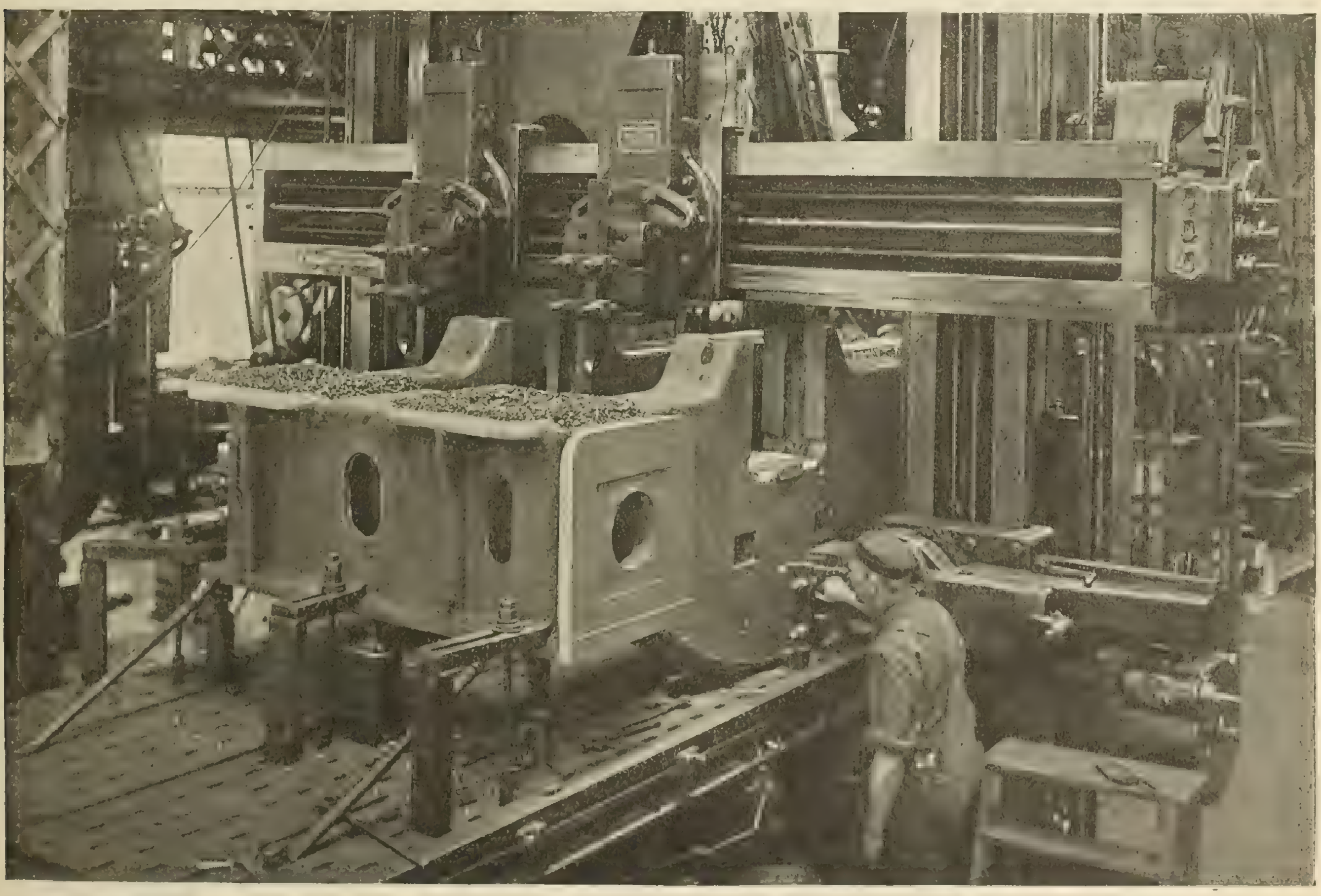


Fig. 1.—One Section of Bedplate Set Up on Planer Where the Joints and Housing Facings Are Planed Simultaneously

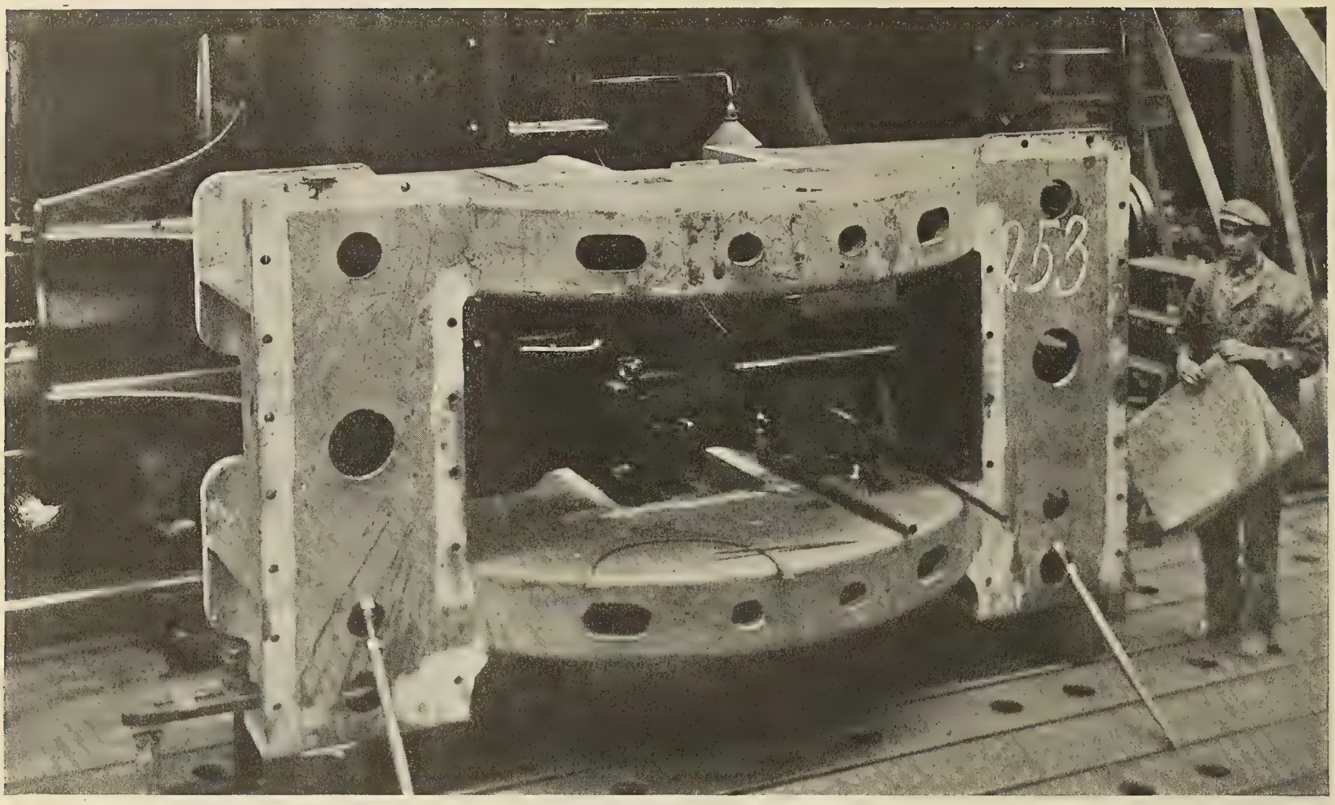


Fig. 2.—Section of Bedplate Set Up on Wall Planer Where the Recesses for the Main Bearings Are Machined

The thrust bearing is of the horseshoe type, with ten collars and fitted with a steady bearing at each end.

Bedplate

The bedplate is the basic unit of a marine engine, and it is of prime importance that both material and workmanship be fundamentally right.

When the width and length of a bedplate exceed the capacity of a planer, it then becomes necessary to machine it in sections as illustrated. The first operation is shown in Fig. 1, where a section is being machined. In this machining it is important that the joints are planed square with the column or housing facings, that the faces for the housings are machined so that the contour of the bedplate will be uniform when assembled; that all flange thicknesses and the length over all, and from center to center of crank pits, be kept to design.

Fig. 2 illustrates the method of machining the recesses for the main bearings on a wall planer. It is most important to set the section so that when it is planed the joints will be square with the sides of the main bearing recesses and the facings for the housings parallel with the bottom of the main bearing recesses. Having the section thus set, the width of the recess is accurately machined to a pin gage, and the distance from the housing facing to the bottom of main bearing recess made to a

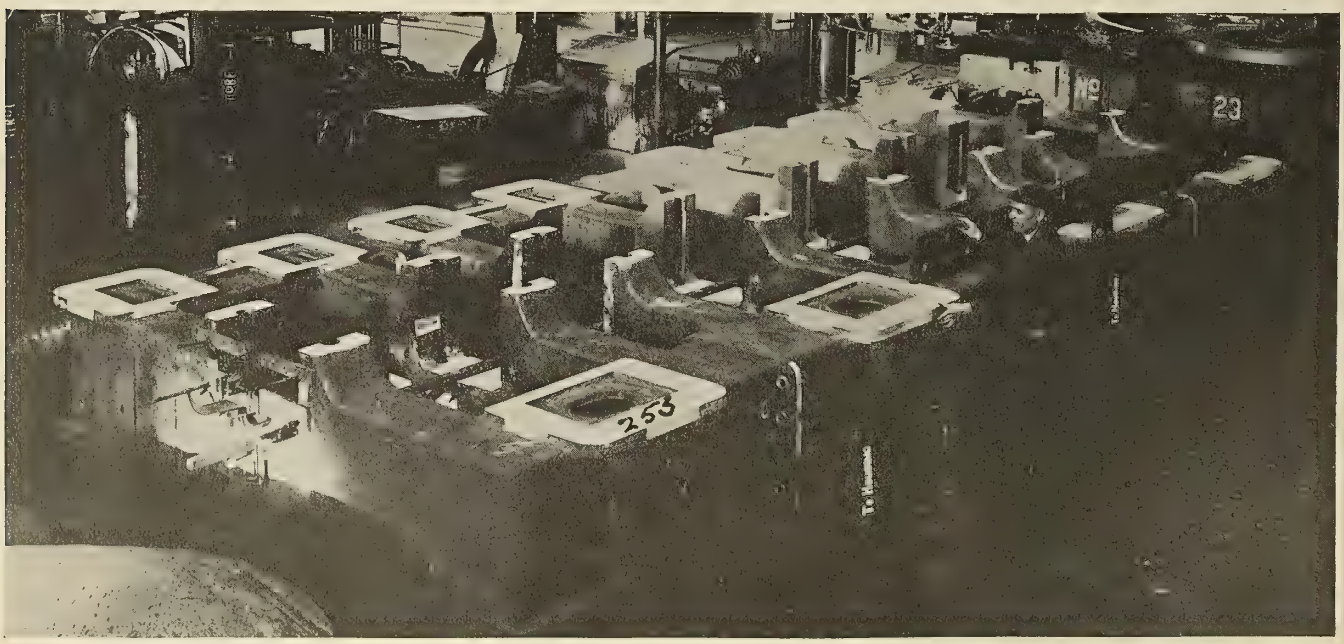


Fig. 3.—Four Sections (the Complete Bedplate) Clamped Together Are Lined Up and Then Laid Out for Drilling, Etc.

block gage. When this operation is complete the sections are taken to the surface table where the machine work is checked, after which holes for holding down bolts, main bearings, and one flange of each joint are laid out for drilling.

After the first drilling operation is complete, the sections are assembled as shown in Fig. 3, and the following operations performed: the housing facings are accurately set on the same plane by the use of a long straight edge and a sensitive spirit level; a fine steel-wire line is made fast at each end of the bedplate, and drawn taut through the center of the main bearing recesses, and in the same plane with the facings for the housings, after which the sections are shifted until the sides of the main bearing recesses are central with the wire line and in alinement, and spots for reassembling chipped, filed and scraped on each joint; centerlines parallel to the wire line are drawn on the housing facings; centerlines at right angles to the wire line and through the center of the crank pits are drawn on the housing facings; templates are then placed on the housing facings so the centerlines on the templates coincide with the centerlines on the facings, and from these templates holes for drilling are scribed off. Having previously mentioned that one joint flange at each section was laid out and drilled, the others are now scribed off and the bedplate is taken apart for the final drilling. After the final drilling, the bedplate is sent to the erecting shop for general assembling.

Housings or Columns

When the length of housings, or columns, exceeds the width of the planer, the faces of the top and bottom flanges must be milled or faced on some other machine. The housing shown in the illustration is too long for the planer, and in this case a wall planer is used. The same method, however, can be applied when machining housings on either a milling machine or a rotary planer. The first operation, however, is to put them on an ordinary planer and to set them carefully, so that when the faces for the guides are machined and the upper and lower flanges planed at right angles to the guide faces, the axes of the housings will have the correct inclination. Having thus planed the guide face, the housing is taken to the surface table and laid out for length. The bottom flange is next planed square with the guide face, after which the housing is set in a jig (see Fig. 4), where it is planed to exact length.

From the wall planer, it is again taken to the surface table, where the machine work is tested for accuracy. If found within the tolerance limit of .004 inch, it is laid out in the following manner:

With the guide face resting on, or parallel to, the surface table, centerlines are drawn on both the top and bottom flanges, and extended across the edges. The housing is then turned on its side and set so that the centerlines drawn across the flanges are square with the surface table; then other centerlines are drawn at right angles to the first ones, intersecting at the axis of the housing, agreeing with the centerline drawn on the cylinder feet and the bedplate facings, respectively. The templates, which were used in laying out the housing facings on the bedplate and on the feet of the cylinders, are now applied to their corresponding flanges on the housings, and the holes laid out for drilling.

The guide plates which have been laid out and drilled are now clamped to the housings, and the holes for bolting them in place are scribed off on the housings. Before taking the guide plates off they are plainly marked

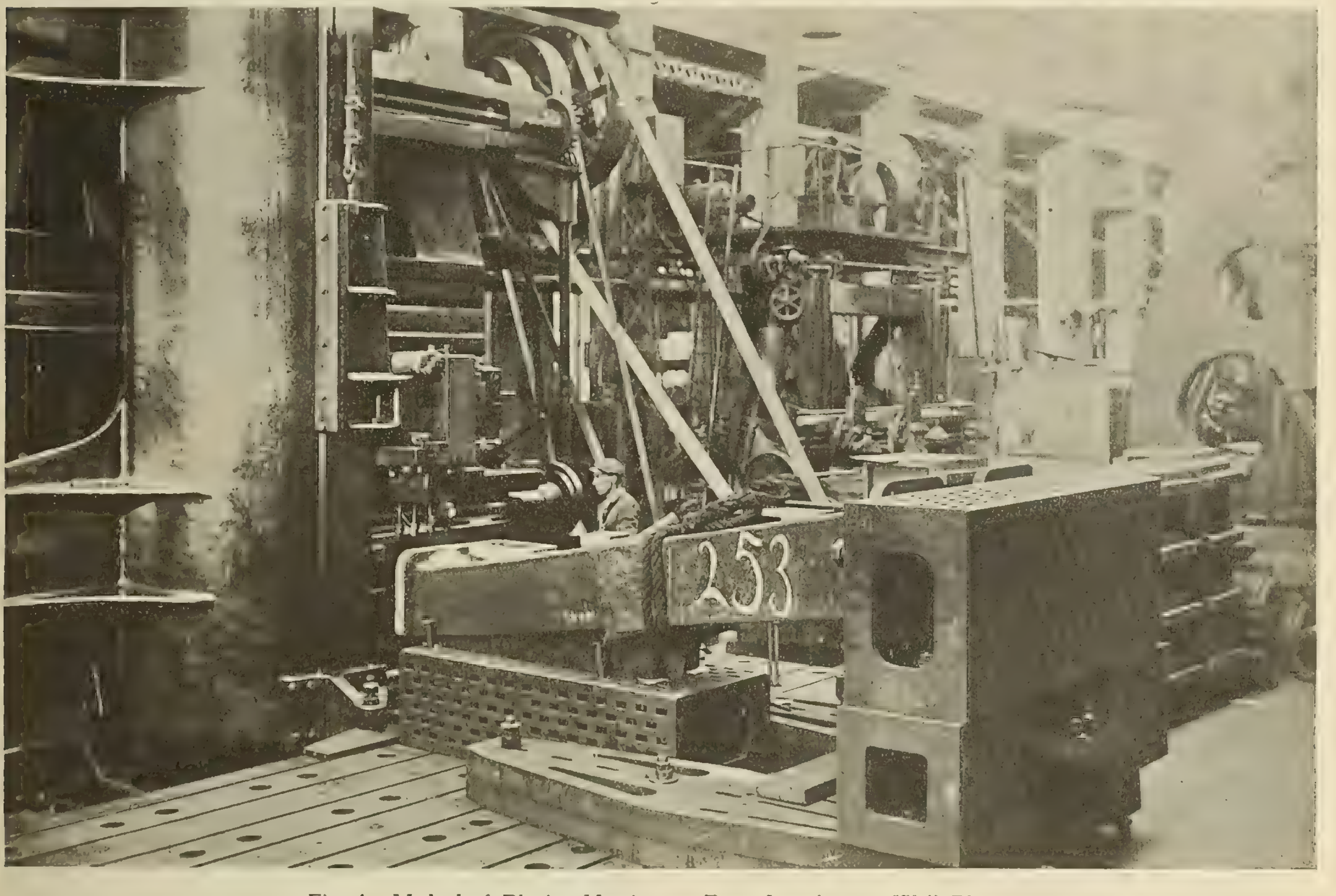


Fig. 4.—Method of Planing Housings to Exact Length on a Wall Planer

for their respective places. The housings are next drilled, tapped, spotfaced and reamed, after which the guide plates are bolted on. The housings are then ready to be erected in place.

Cylinders

The cylinders of an engine are among the most prominent parts, and when in process of machining they should be so handled that every detail of the work is executed with care. When first received from the foundry they are pickled in a solution of one part sulphuric acid to four parts water to loosen the sand and scale, then placed on a surface table, inspected and carefully laid out for machining. The bore must be smooth, accurate and parallel, and the length of the wearing surface such that when the piston has the correct amount of clearance, top and bottom, the rings will slightly overrun to prevent wearing

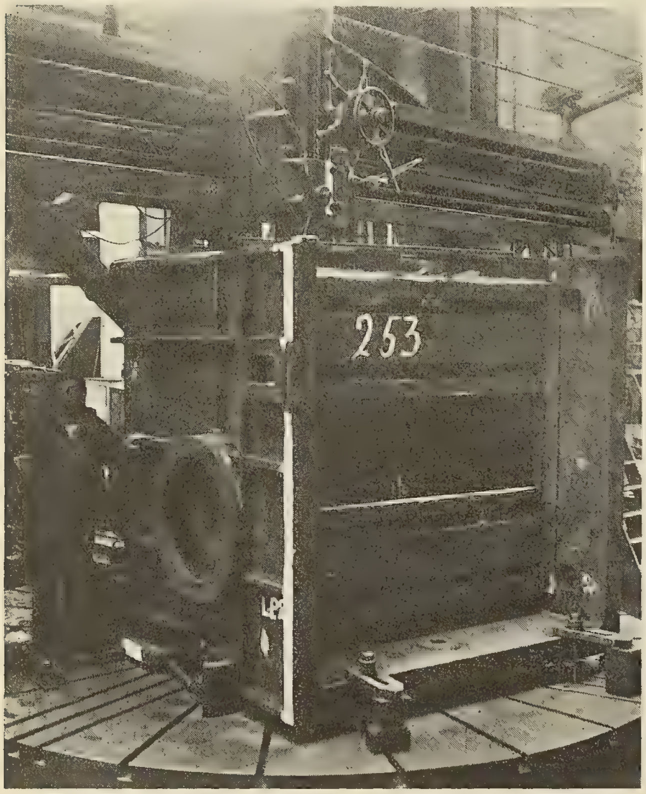


Fig. 5.—Boring a Cylinder on a Large Vertical Mill

shoulders. Marine-engine cylinders should be bored in their working position vertically, or otherwise as the case may be, as shown in Fig. 5.

The cylinder is first set true to the preliminary layout, clamped firmly to the table and bored, using two roughing tools simultaneously, and taking the maximum cuts and speeds possible without producing prominent chatter marks. For the second cut, one roughing tool is used, which leaves the bore cylindrical and uniform for the finishing tool. The third or finishing cut is taken with a tool approximately two inches wide, using about 1-inch feed, and running at a cutting speed of about sixteen feet per minute. This gives a smooth, straight cut, free from chatter marks.

After boring and facing, the cylinder is taken to the planer, where the face of the joint is planed parallel to the bore, and the distance from the center of the cylinder to the face of joint is kept accurately to the given dimensions. A cast-iron mandrel about four feet longer than the cylinder, and turned six inches in diameter to gage size is fixed rigidly and accurately in the center of the bore as shown in Fig. 6. The ends of the cylinder are lowered

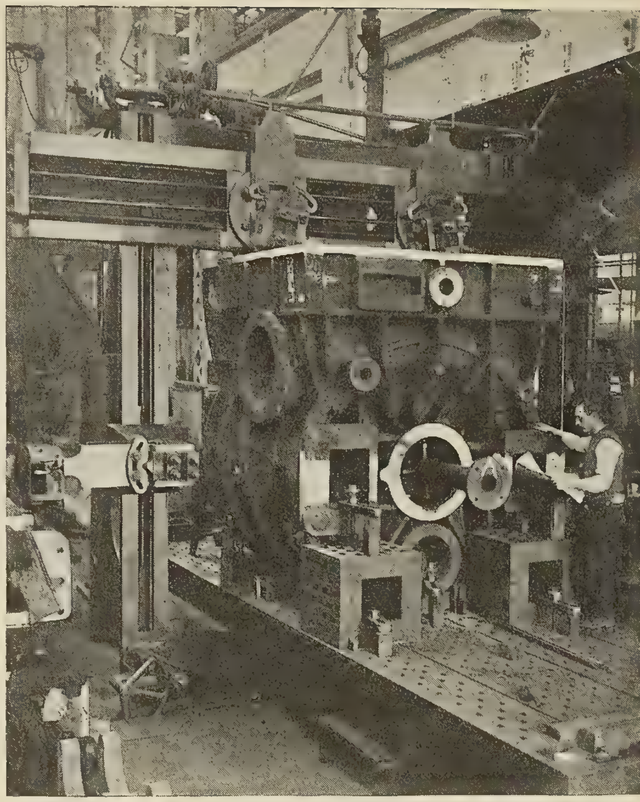


Fig. 6.—Planing a Cylinder Accurately Will Obviate Trouble When Lining Up

or raised, as the case may require, until the distance from each end of the mandrel to the crossrail caliper is the same. The same principle is then applied from the side head to the mandrel. Having the cylinder set, the dimensions for machining are taken from the circumference of the mandrel, remembering that one-half the diameter of the mandrel must be considered when measuring. By turning the top of the cylinder downwards, with the finished face on or parallel to the planer table it is now in a position where its feet can be planed at right angles to the bore by using the crossrail head. The next operation is to

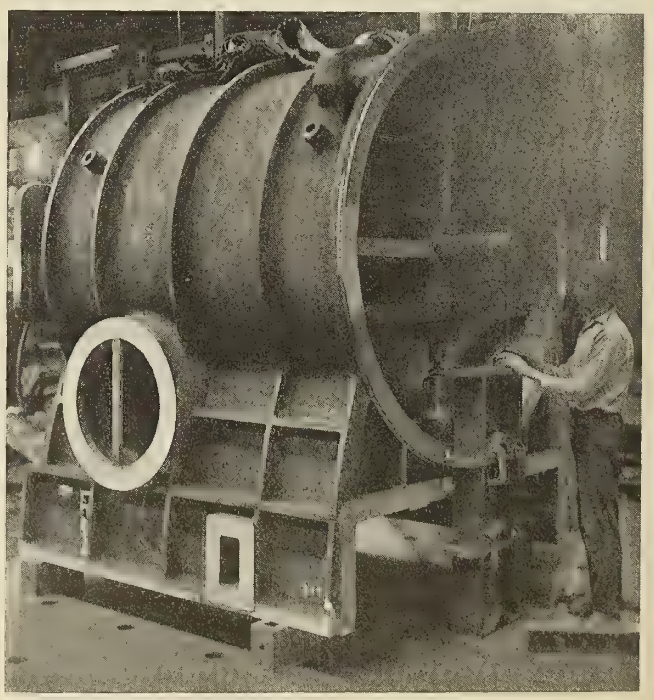


Fig. 7.—Carefully Checking All Machine Work and Laying Out for Drilling and Assembling

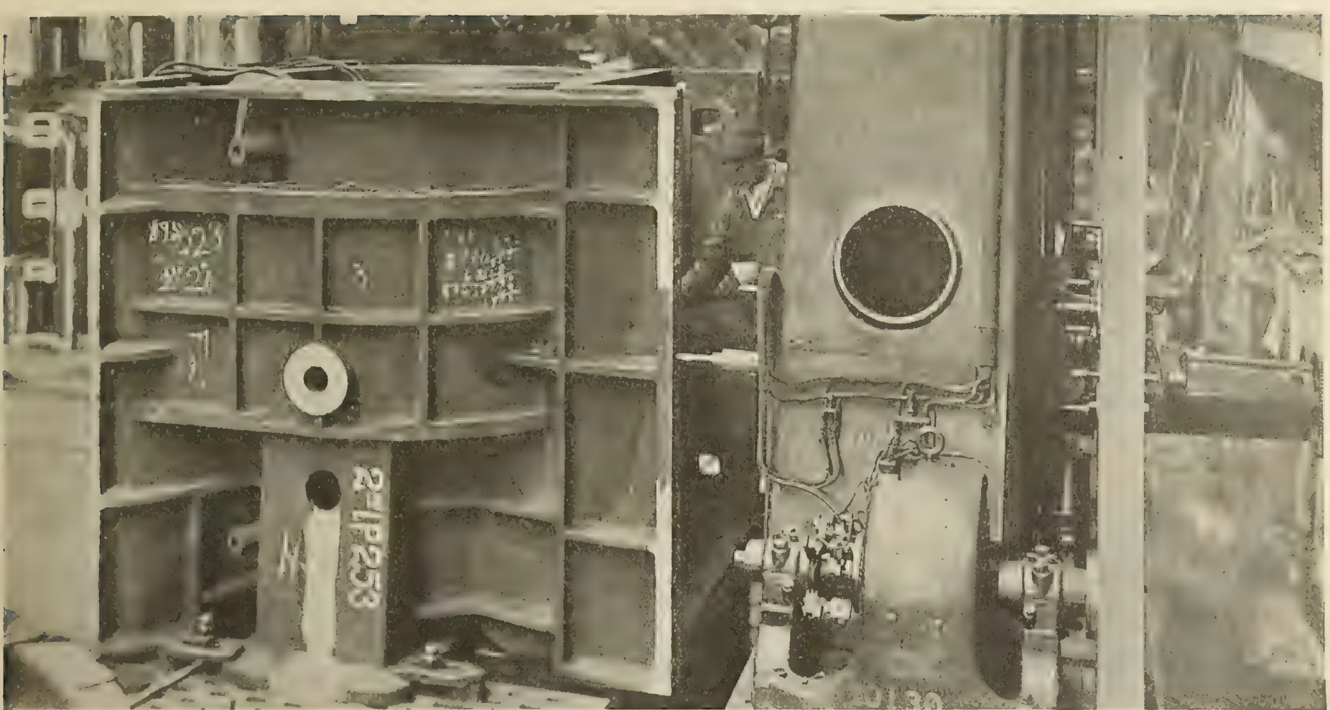


Fig. 8.—Drilling Holes in Cylinder on Horizontal Drill Press

check carefully all machine work and layout for drilling.

The method of laying out cylinders differs according to their type, but the essential features of the process are the same in all cases. The cylinder chosen for illustration is shown in Fig. 7, and is a low-pressure cylinder of the double-ported slide-valve type, 75-inch bore by 51-inch stroke. The work of laying out is done in two operations, as follows:

First: The cylinder is placed on parallel blocks on the surface table with the joint down and with a cast-iron mandrel, as previously described, set central with its bore. By the use of surface gage, straight edge, and a large square. centerlines are drawn fore and aft, and athwartship. Templates for laying out the feet are then set, and the machining of the joint checked from the mandrel. After all the accessible surfaces are laid out and the machine work checked the mandrel is removed, and the length of wearing surface, counterbore and clearances are measured for accuracy.

Second: The cylinder is then placed on its feet, and from the face of the feet as a base the remainder of the spacing and checking is done.

After the layout is finished the cylinder is taken to a horizontal drill press (see Fig. 8), where all holes are drilled, spotfaced, tapped and reamed according to the stamped or other marked instructions put on by the layer-out. After drilling, all internal parts such as steam passages, etc., are thoroughly cleaned and fins removed; the valve liners, or false faces, and other fittings are assembled, some permanently and others temporarily, to insure the accuracy of workmanship.

Crank Shaft

When all the auxiliary parts have been fitted and proved correct, the cylinder is subjected to a hydrostatic test of about double its working steam pressure. While under this pressure, every part is carefully examined to see that the casting is perfectly sound and free from hidden imperfections. If no defects develop, the water is drained out and the cylinder is ready to take its place in the final assembly of the engine.

The crank shaft of a marine engine, being one of the most important parts, should, to insure the utmost security in service, embody only the highest grade of material and of mechanical excellence.

After the shafts, pins and webs are forged and annealed, two coupons or test pieces are taken from each forging for tensile and bending tests. If the tests meet the requirements, the pins and shafts are rough turned to within ¼ inch of their finished sizes, to ascertain that the metal is free from imperfections. The webs are laid out and holes for the shafts and pins cut with an acetylene torch, leaving them about 2 inches smaller in diameter than the desired bore.

The webs are again annealed and planed to the re-

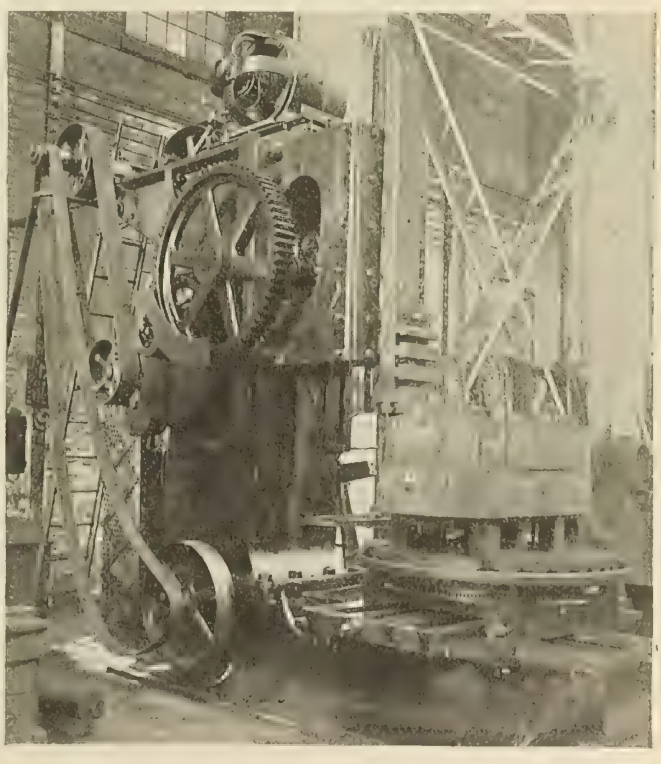
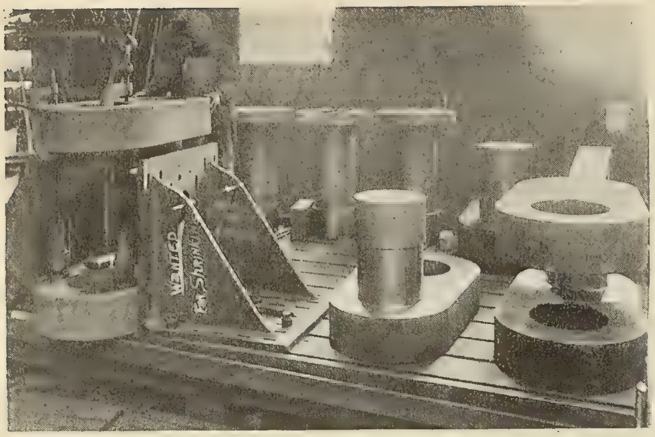
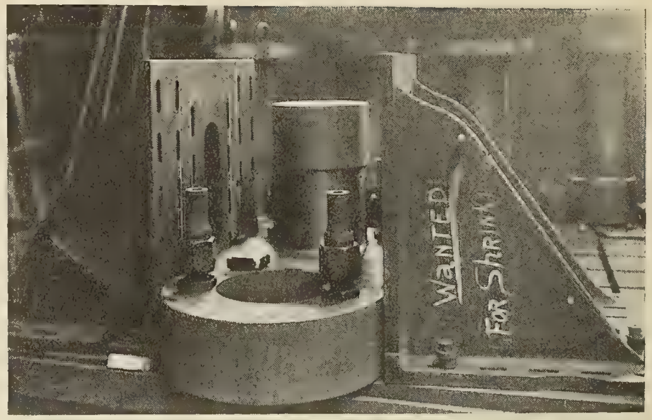


Fig. 9.—Slotting the Ends and Sides of Crank Webs on a 42-Inch Slotter





Figs. 10 and 11.—Shrinking Crank Webs Accurately on Pins and Holding Bore for Shafting in Perfect Alinement

quired thickness, laid out for machining, clamped together in pairs, and put on a vertical mill, where the holes for shafts and pins are bored smoothly and accurately to a pin gage. The keyways are cut on a keyseater, after which the clamps are carefully changed to the inside of the bore, so that the edges of the webs can be machined parallel to the bore. The ends and sides are machined to finished size on a slotter (see Fig. 9). After being completely machined the webs are marked high pressure fore and high pressure aft, etc., separated and all outside corners rounded.

The pins are turned for shrinkage in the webs, and the journals are ground to snap-gage size for connecting-rod bearings. An allowance of .001 inch to the inch diameter for a shrinkage fit has proved entirely satisfactory for crank shafts and pins.

The end pieces of the crank shaft are rough-turned only, except the fit for shrinking and the adjacent end, which are finished. On the sections which couple the high pressure and low pressure, and the first and second intermediate pressure together, only the faces inside of flanges and the fillets of the coupling are finished. These shaft ends are then laid out, keyseated, drilled, reamed and fitted with coupling bolts. After this they are put in a lathe and turned for shrinkage fits, faced to correct length, and spots turned on each section close to the coupling fillet for future checking after the parts are assembled.

It might be well to state that with the use of a little "shop trig," the laying out of the eccentric keyways in a crankshaft may be done easily, and with a high degree of accuracy. After completing the foregoing operations and preparatory to assembling, the work is checked and a pilot key tried in all keyways.

The first step in assembling is to heat one web of each crank and to shrink a pin in place. Two accurate angle plates are set on a heavy cast-iron plate, and made fast to suit the width of the webs (see Figs. 10 and 11). A web having a pin shrunk in is then placed on the plate between the angle plates with the pin up, leaving a definite amount of clearance on each side to allow for the other web when expanded. On the face of the lower web, and close to the outer edges, four distance pieces, with length equal the distance between the webs, are arranged. Then the expanded web is placed, and the axis of the bores for the shafting is kept true to alinement, while the webs are held the prescribed distance apart. The application of cooling water must be uniform to obtain uniform contraction of metal.

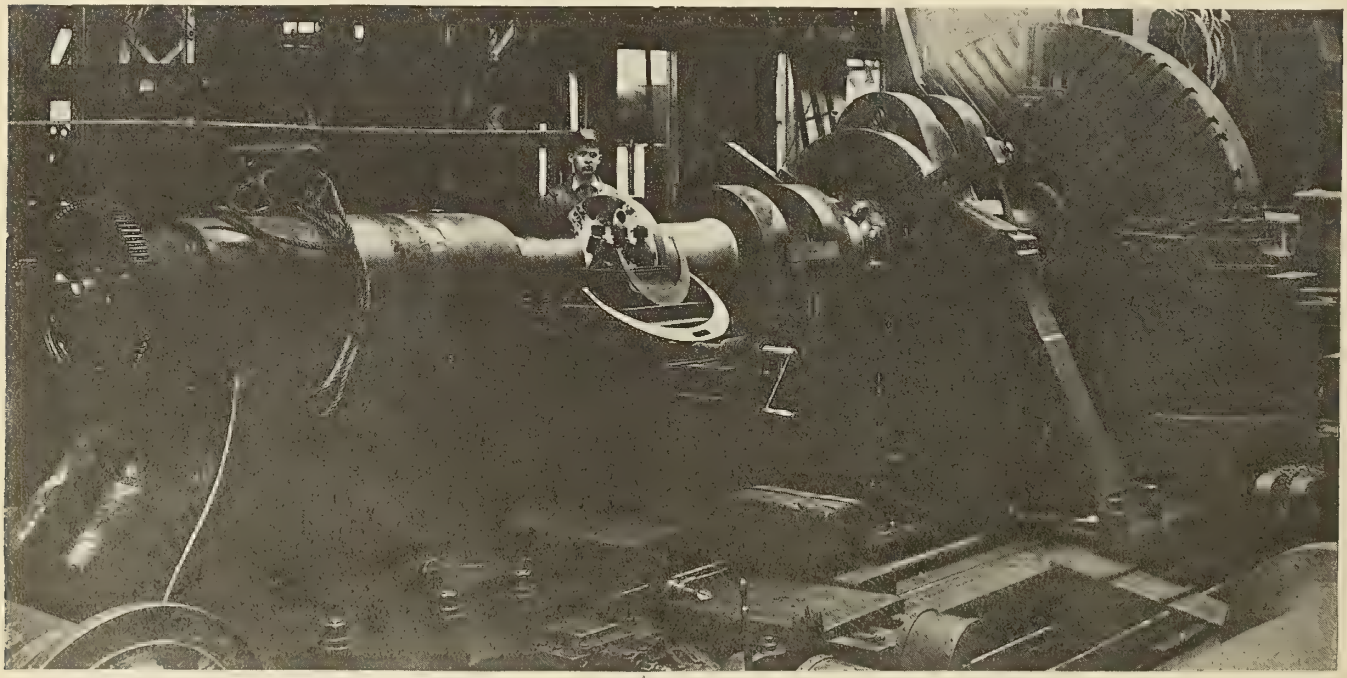


Fig. 12.—Two Sections of Crank Shaft Assembled and Set Up in Lathe Where It Is Turned to Exact Gage Sizes

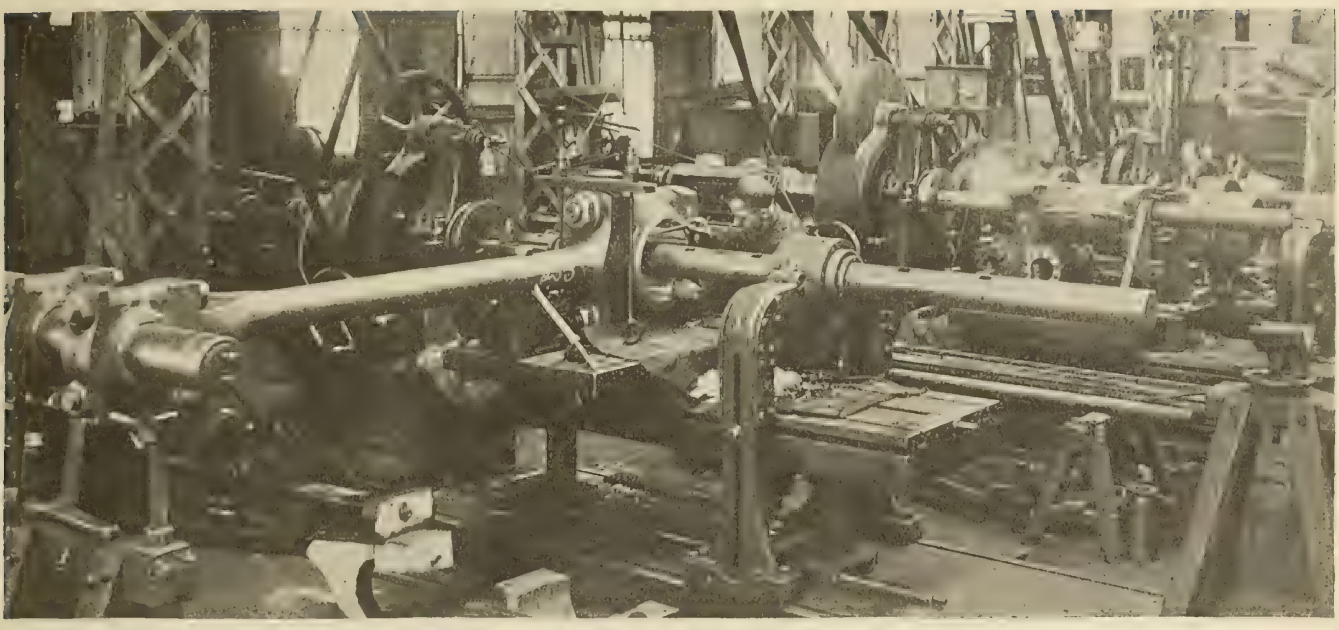


Fig. 13.—Connecting Rod Set Up on a Horizontal Boring Mill Where the Upper and Lower Bearings Are Bored in Perfect Alinement

After the webs are cooled, one web is heated for the shaft end, and a section shrunk in place. To keep the keyway true, and the end of the shaft even with the inside of the web, a pilot key is used and a heavy parallel, extending across the underside of the web, held firmly in place by small jack screws made for such purposes. After the shaft is shrunk in place, the key is fitted and driven in with a ram.

The same method is used for the opposite web, except the key has to be forced in with a jack, as there is no room for a ram. In using a jack to force the key in place, the open end of the webs is supported by heavy clamps to prevent any distortion.

After the shrinking operation is complete, and all keys are fitted and forced into place, the sections are assembled and set to lines previously put on by the layerout. The holes are then reamed and coupling bolts fitted. Distance pieces are fitted between the webs so that when the complete shaft is placed in the centers of the lathe it will be rigid (see Fig. 12).

Having the shaft in the lathe centers with a support near its center, but allowing it freedom to show its true character on the dials of micrometer indicators placed at or near each end, and at or near the center on the spots previously turned for this purpose, will beyond question reveal the class of workmanship previously performed when machining, shrinking and assembling. Should the shaft not run true, the centers must be drawn so that the inaccuracies will be equalized in the shaft, and at the same time so that the pins will be absolutely parallel to the shaft when finished.

After the shaft is centered to meet these conditions, the couplings and shaft are turned smoothly and accurately to snap gage. All journals are first turned true and smooth about .003 inch large with a dry cut, after which a water cut is taken, which leaves them smooth and polished. The crankshaft is then taken to the erecting shop, where the eccentric keys are fitted and the eccentrics clamped in their places.

Connecting Rods

As the connecting rod is subjected to various and severe stresses, it is very important that the machining, assembling, and final boring be removed entirely from the domain of chance and reduced to a practical certainty. Fig. 13 shows an assembled rod receiving its final boring. After the body of the rod has been turned, the greatest care should be taken to see that the ends are faced off true, and to the exact length, before it is removed from the lathe. The rod is then laid out, drilled, assembled and laid off for the final boring of the bearing boxes.

The crosshead end bearings are bored accurately to size and parallel to the faces of the upper end. A cast-iron mandrel about two feet longer than the upper end is made and snugly fitted in these bearings. When setting the rod for boring the crank and bearing, the mandrel is kept in the crosshead end bearings and, with a sensitive V-shape spirit level, the mandrel is set on the exact horizontal plane with the boring bar. It is then set parallel to the bar by use of the caliper tram shown. When thus set and bored, the bearings in the upper and lower ends are parallel.

Radius Links

Radius links are machined in various ways, according to the shop equipment available. The process described gives entire satisfaction and reduces the fitting work to a minimum.

Temporary holes are located, drilled and tapped in the link bars, for holding them on the planer table while

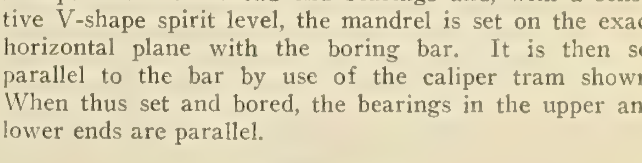


Fig. 14.—Method of Holding Link Bars on Planer Table When Taking the Last Finishing Cut

machining. (These holes are so located that when holes for pins are bored and reamed they are machined out.) Either four or eight link bars are fixed on the planer table at one time, where they are rough machined on both sides; then one side is finished smooth and true, leaving 1/32 of an inch to come off the opposite side after the pins are riveted in place.

After the first planing operation they are laid out,

clamped together in pairs, drilled, bored, reamed, and countersunk for pins. They are then marked and separated, and the pins pressed into place and riveted, after which the face of the link bar is tested to ascertain if it has been distorted, and the pins to see if they are square with the face of link bar. After being proved correct, they are placed on the planer (see Fig. 14) with the pins down and in thimbles, where the unfinished sides are machined smooth and the link bars made to thickness.

After experimenting with various cutting compounds to obtain a smooth, accurate finish on this work, spirits of turpentine and kerosene (paraffin) oil mixed in equal quantities and applied with a brush was found to give the best results.

Link Blocks

Link blocks are first subjected to a preliminary layout, then turned and faced for width and length. After this

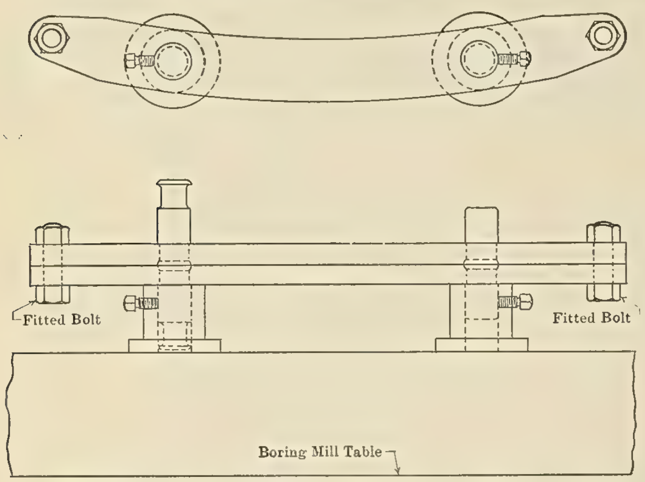


Fig. 15.—One Set of Link Bars on Vertical Boring Mill Table. Usually Four or Six Sets Are Turned and Bored at One Time

they are arranged on the planer in a double row, so that two tools can be used simultaneously for machining. When one end is finished they are turned over, with their faces on the table, and planed sides against heavy parallels or straight-edges set true to the travel of the machine. This brings the rows of blocks in line with very little effort, and should one or more chance to shift, they would be easily detected. After the planer work is finished, brass gibs or shoes are fitted, and secured in place by tap bolts. The blocks are then laid out and placed on a vertical boring mill, where one end is bored to the correct diameter and the width to gage.

Before boring the opposite end, cast-iron pieces about an inch or more longer than the link blocks are clamped to the table, and turned the same diameter as the link bar. The link blocks are then put on the table with the finished end down, and with the gibs hard up against the cast-iron pieces, are turned to the correct diameter and the width to gage.

They are then moved from the boring mill to the fitting department, where the oil ways are cut and the link blocks fitted to the links.

The link bars and link blocks are machined to gage size (or metal to metal) so that when the rough spots are removed and the link bars polished an exact working fit is obtained. After planing, the links are clamped together in pairs to previous markings. Fitted bolts or snug-fitting bushings are used in the reamed holes in each end; these hold the pins in both link bars in positive alinement. One side is then laid out for machining, after which the ends and the portion up to the radius is slotted.

From the slotter they are taken to a large vertical boring mill (see Fig. 15), where they are placed on the table in sets of from three to eight. They are mounted in thimbles as in the last planing operation, and are set true to layout. The pins are then tried, to insure that they will be true and central when the turning is finished. The links are bored to the correct diameter, and width, measuring the width with a snap gage. They are next taken apart and any rough parts and sharp corners which may have been left in machining are filed and polished, after which they are ready for assembling and for fitting the link blocks.

Thrust Shaft

Fig. 16 illustrates the process of turning a thrust shaft. When roughing, four tools are used simultaneously, using a good cutting speed and heavy feed.

After the shaft is rough turned all over, the collars and recesses are finished to gage with a very smooth dry cut. The other surfaces are also finished dry except the pillow block journals, which are first finished dry approximately .003-inch large and then turned to snap-gage size with a water cut. After the shaft is turned the collars are polished to obtain the best finish possible for the thrust-shoe bearings. The shaft is then laid out to

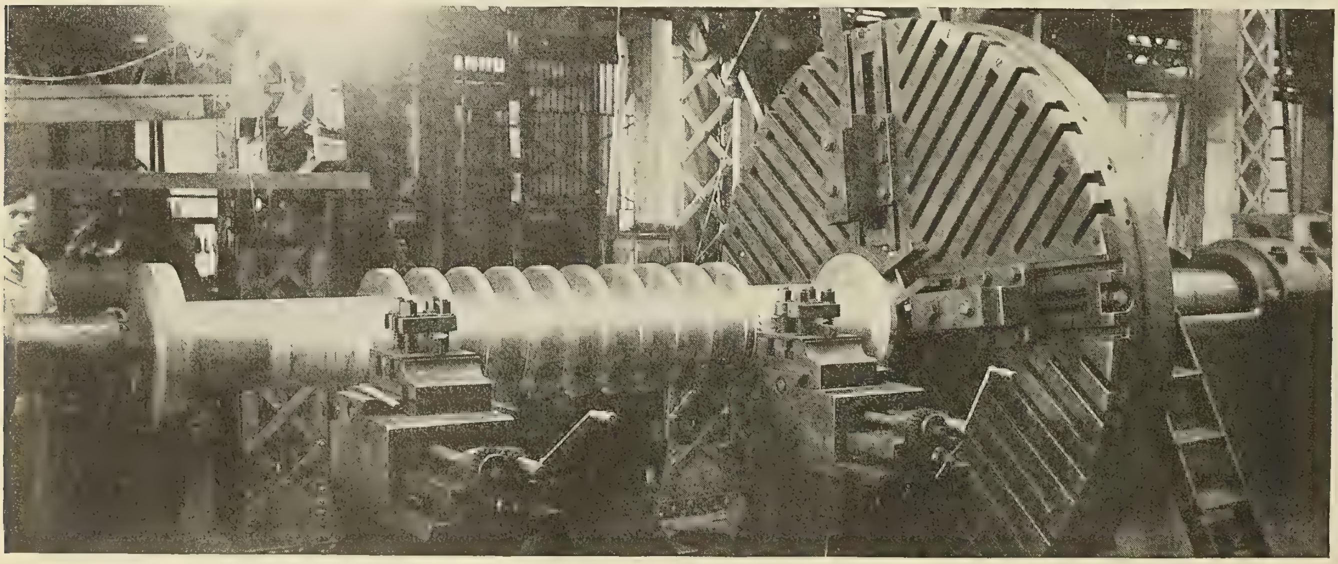


Fig. 16.—Turning a Thrust Shaft Where Four Tools Are Used Simultaneously When Roughing

template, drilled, spot-faced, and reamed to suit the adjacent couplings.

Line Shafts

A dry, smooth finishing cut is taken over all-line shafts, except the steady bearing journals, which are finished to size with a water cut and polished. The couplings are faced true, and before reaming are tested in the following manner: a thin coating of marking mixture, such as red lead thinned with lard oil, is rubbed over the face of one coupling, the other coupling is then drawn hard up against it and separated; if the surfaces are covered with bearing marks from the periphery to at least three inches inside the bolt holes, they are again carefully assembled so as to obtain absolute concentricity, and the holes reamed and coupling bolts fitted. Both the couplings and the bolts are clearly marked for their positions. This being done, the shafting is taken apart and painted all over, except the journals and coupling faces (which are coated with oil), and sent out for installation in the ship.

Thrust Shoes

The method of handling thrust shoes from the rough casting to the finished product is as follows:

They are laid out, drilled and tapped for water circulation, thoroughly cleaned inside and out, and all fins and other obstructions removed. Each shoe is then subjected to a hydrostatic pressure of 30 pounds per square inch, to prove its fitness for use. The sound shoes are babbitted and machined .010 inch less than the recess in shaft, to allow for working clearance. For forced lubrication, the clearance is less, usually about .005 inch. After machining for thickness the shoes are clamped together in sets for boring and planing, the end shoe having been laid off for this purpose. Fig. 17 shows a set of shoes on the planer.

After the boring mill and planer work is finished the shoes are laid out, drilled and spotfaced. They are then taken apart, and the oil grooves are cut and all the equipment fitted. After correctly locating the thrust shaft in the bearing, the thrust shoes are clamped in their places and tested for working clearances.

Erecting a Marine Engine

A marine engine should in all cases be erected as completely and as perfectly as possible before it leaves the shop, as the entire equipment of the shop is available, and the work can be done there to better advantage than on shipboard.

It is very important that the foundation should be rigid, so that there will be no danger of the bedplate springing under the heavy weight of the various units placed upon it.

Bedplate

The first step in assembling is to place the bedplate on the foundation and set the sections accurately to the spots chipped, filed and scraped at each joint, and to bolt them together. The bedplate is then leveled with a very sensitive and accurate spirit level, placed on straight edges. This requires considerable care, as the operation of leveling first one side and then cross-leveling to the other is repeated several times until no further error can be detected. The leveling wedges and shims must be so arranged as to take the ultimate weight without disturbing in any way the true condition obtained. After the bedplate is level and accurately in line and resting on a rigid foundation, the holes are reamed and bolts fitted at each joint.

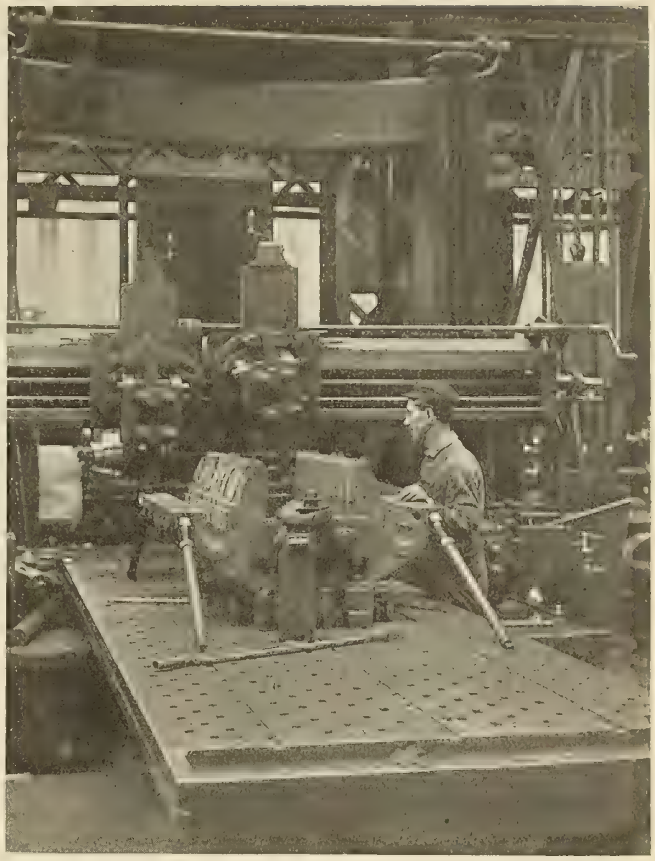


Fig. 17.—Planing Ten Horseshoe Thrust Bearings at One Time

The housings are next set so that the lines on each bottom flange coincide with similar lines on the bedplate, thus bringing the housings approximately to their true position. One long straight-edge is then clamped across the guide faces of the back housings, and another to the sides of the main bearing recesses, each in a horizontal position. Three plumb lines are then hung from boards fastened to the tops of three housings, with their bobs suspended in pails of oil on the floor. The first two (Nos. 1 and 2) are hung from the end-back housings, and set equidistant (using a gage) from the straight-edge clamped to the housings, and the third (No. 3) is hung to a front housing (on the opposite side) and set so that it passes through the center of the main bearing recesses (see Fig. 18).

Housings

The distance from plumb lines No. 1 and No. 2 to the lower straight-edge clamped to the side of the main bearing recesses is gaged to determine if the guide faces are parallel to the main bearing recesses. The third plumb line (No. 3) is used to check the distance from the guide faces to the fore and aft centerline of the engine. Should these points check incorrectly, the housings should be shifted until they are in their correct positions.

Having the back housings accurately set, the front housings are adjusted to their true position from them. Holes are then reamed through the lower flanges, and the bedplate and bolts fitted, and two spots chipped across the joint of each housing for reassembling purposes.

The next step is to prove that the top facings of the housings are exactly on the same plane. This is done by placing a long straight-edge on the facings with a sensitive level on the straight-edge, and using feelers or thickness gages between the housing facings and the straight-edge. This test is applied forward and aft, and athwart-

ship, and at no place should there be found an error to exceed more than .002 inch. Should a greater discrepancy than this show, the error must be corected by filing or re-machining the faces.

Main Bearings

With the housings correctly set, the main bearings are next fitted. The load on the crank shaft and main bearings, due partly to the weight of the shaft and partly to the alternate push and pull of the connecting rods, is more or less oblique, and is consequently severe, and for that reason no doubtful material or workmanship should, under any consideration, enter into the construction of the bearings.

The bearing boxes are first machined slightly full to allow for fitting; a very thin coat of red lead is applied to the sides and bottom of the main bearing recesses; the sides and bottom of the boxes are smoothed and then tried in place; high spots or tight places are removed with a scraper until the boxes show a true bearing on the bottom and both sides. The caps are likewise fitted, after which the distance pieces and liners are put in place, and the main bearing nuts hammered up hard. A fine wire line is then stretched through the main bearings and set central in the main bearing recesses and in the exact location of the centerline of the crank shaft. Having previously tested the wire line, allowance for sag is readily determined, and the wire line raised accordingly in way of each bearing.

From the wire line, five points are accurately located on each end of the main bearings. The wire line is then removed and the main bearings taken out of their places, and set on a horizontal boring mill accurately to the points on each end and bored to size. The oil ways are then cut, after which the lower bearings are put in their final places.

A cast-iron mandrel which has been turned to the diameter of the crankshaft is given a light coat of red lead and placed in the main bearings and rotated a few times. The mandrel is then raised out of the bearings and the high spots on the bearings scraped off by hand. This operation is continued until all the lower halves of the main bearings show good-bearing surfaces.

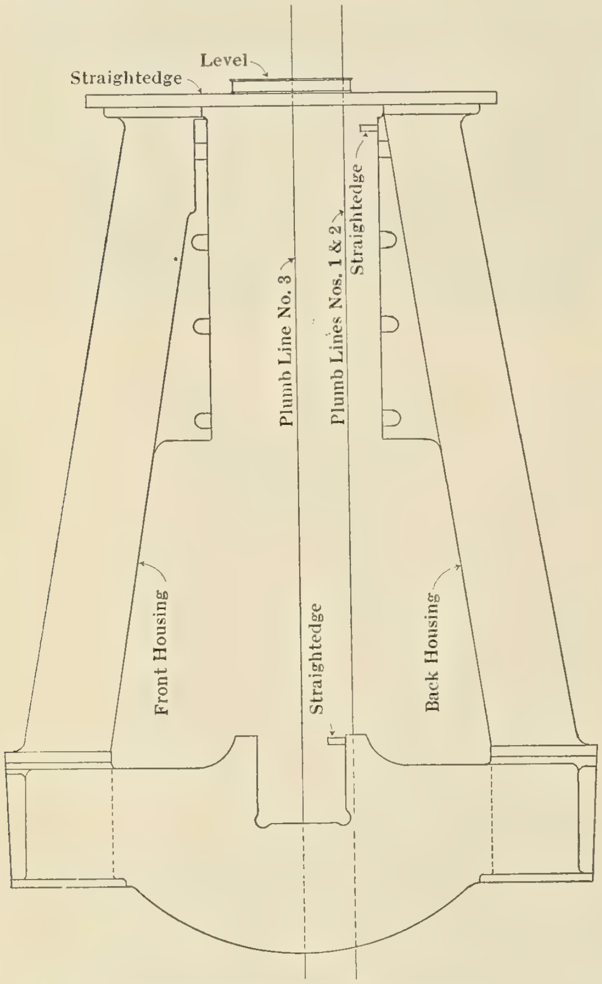


Fig. 18.—Method of Lining Up Housings

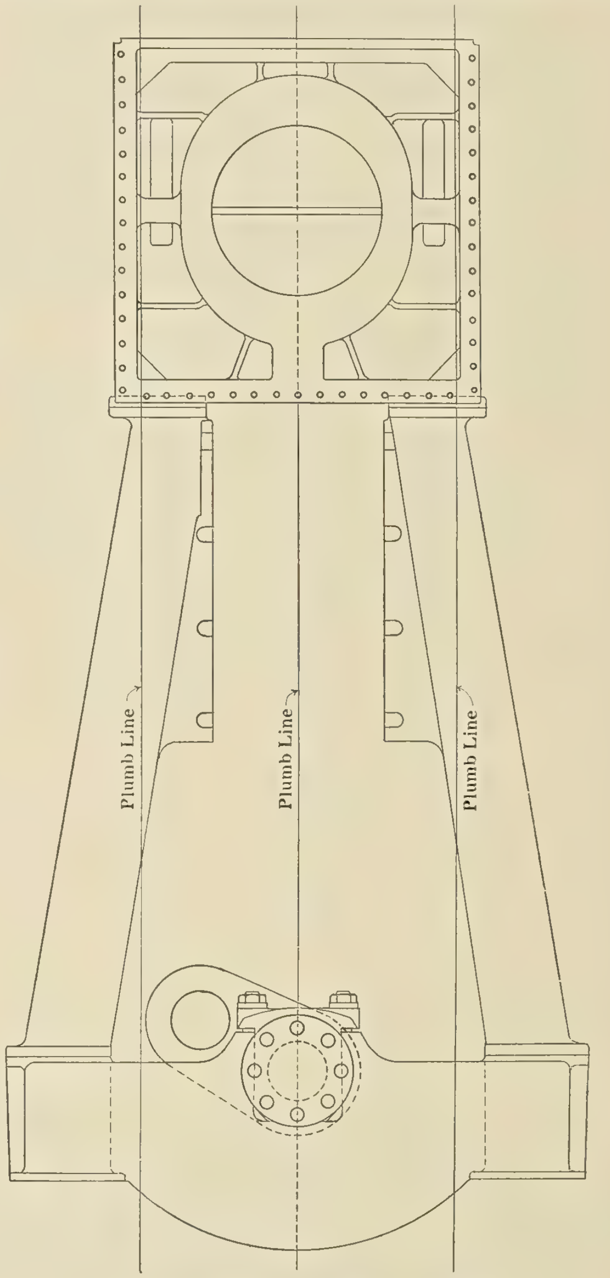


Fig. 19.—Method of Lining Up Cylinders

In the engine being described, the crankshaft is long, and is turned in two sections. The two parts are placed in the bearings and set to the required sequence, and the holes are reamed and coupling bolts fitted. The crankshaft is now given a very thin coat of red lead, rotated and then removed. Should any imperfection show, the bearings must be scraped until practically perfect bearing surfaces are obtained.

The main bearing caps are next placed in position so

they bear on the crankshaft, which is again rotated and, as was done in case of the lower bearings, they are scraped to a fit.

Sheet-metal liners of sufficient thickness to give the shaft .015 inch working clearance are interposed between the bearings and caps; this is to insure sufficient space for a film of oil to lubricate the shaft, when the main bearing-bolt nuts are hammered up tight.

Cylinders

The crankshaft having been properly bedded in the bearings, the cylinders are next put in their places and lined up.

In this engine, the second intermediate-pressure cylinder is first erected in place, and is set so that the lines on its feet and those on the housings coincide. Three plumb lines are used in setting this cylinder. One is set so as to pass exactly through the axis of the cylinder and extend down to the floor with its bob suspended in a pail of oil. The other two are hung from the top of the cylinder, equidistant from the first, and near the outer edge of the joint with their bobs likewise suspended in pails of oil (see Fig. 19).

The objective is to set the cylinder so that the line passing through the axis of the cylinder will pass at right angles through the axis of the crankshaft, and that the other lines will be at right angles to the centerline of the crankshaft. The cylinder is carefully shifted until the above conditions are fulfilled, and then it is bolted hard in place. The low-pressure, first intermediate-pressure and high-pressure cylinders are then set in place and a plumb line hung from the top of each cylinder passing through the axis, and set so that it passes at right angles through the axis of the crankshaft.

Having the cylinders set, holes are reamed through the feet and housing flanges and bolts fitted.

Reverse Shaft Bearings

The reverse shaft bearings, having been previously bolted and doweled in their places, are lined up for boring with a steel-wire line stretched through them, and set at the centerline of the reverse shaft. Points are located for setting on the boring mill as was done in the case of the main bearings. After the bearings are bored, they are finally secured in their places, and the bearings scraped to a true bearing, using the reverse shaft for this purpose.

Main Engine Guides

Guide plates are usually machined slightly oversize in thickness, so that when they are re-machined they will conform to the plans. After machining they are drilled, tapped and thoroughly cleaned, and then subjected to a hydrostatic test of 30 pounds per square inch to insure against leakage of cooling, circulating water. They are then bolted in place and lined up for final work.

It is obvious that when an engine is under steam the temperature of the cylinders is much greater than that of the bedplates; therefore, the expansion of the mass of metal in the cylinders greatly exceeds that of the bedplates. When lining up marine engine guides, this must be taken into consideration; else, when the engine is warmed up the guide faces will be closer together on the lower end than at the top.

The method used for lining them up is as follows: A plumb line is again set central at the top of the cylinder, and passed through the center of the stuffing-box perpendicular to and through the axis of the crankshaft. Then the distance from the guide faces to the plumb line is very accurately gaged from top to bottom, and the condition noted on sketches. They are then taken down and the amount to be machined off is stamped plainly, so that when they are finally put in position they will be gaged to size on the bottom end, and .10 inch smaller on the top, with each guide face, from the bottom to the top, having an inclination of .005 inch toward the center.

After years' of experience this has proved a most satisfactory method of lining and fitting up guides. While it may be a little expensive and require extra time, the importance of the parts should demand only first-class workmanship.

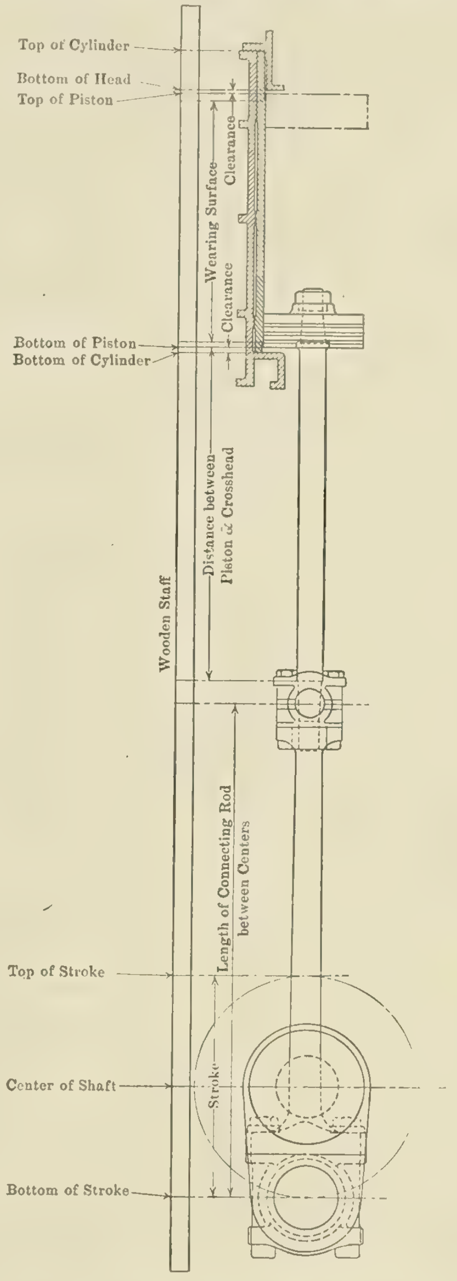


Fig. 20.—Method of Getting Exact Length for Machining Piston Rod

Getting Cylinder Clearances

Definite clearances at the top and bottom of the cylinders are imperative, and they should be marked plainly for the future use of the engineer and for subsequent overhauling operations. Liners should never be interposed between the lower end of the connecting rod and the crank-pin bearings on new work. As previously stated the connecting rods should be machined to exact length

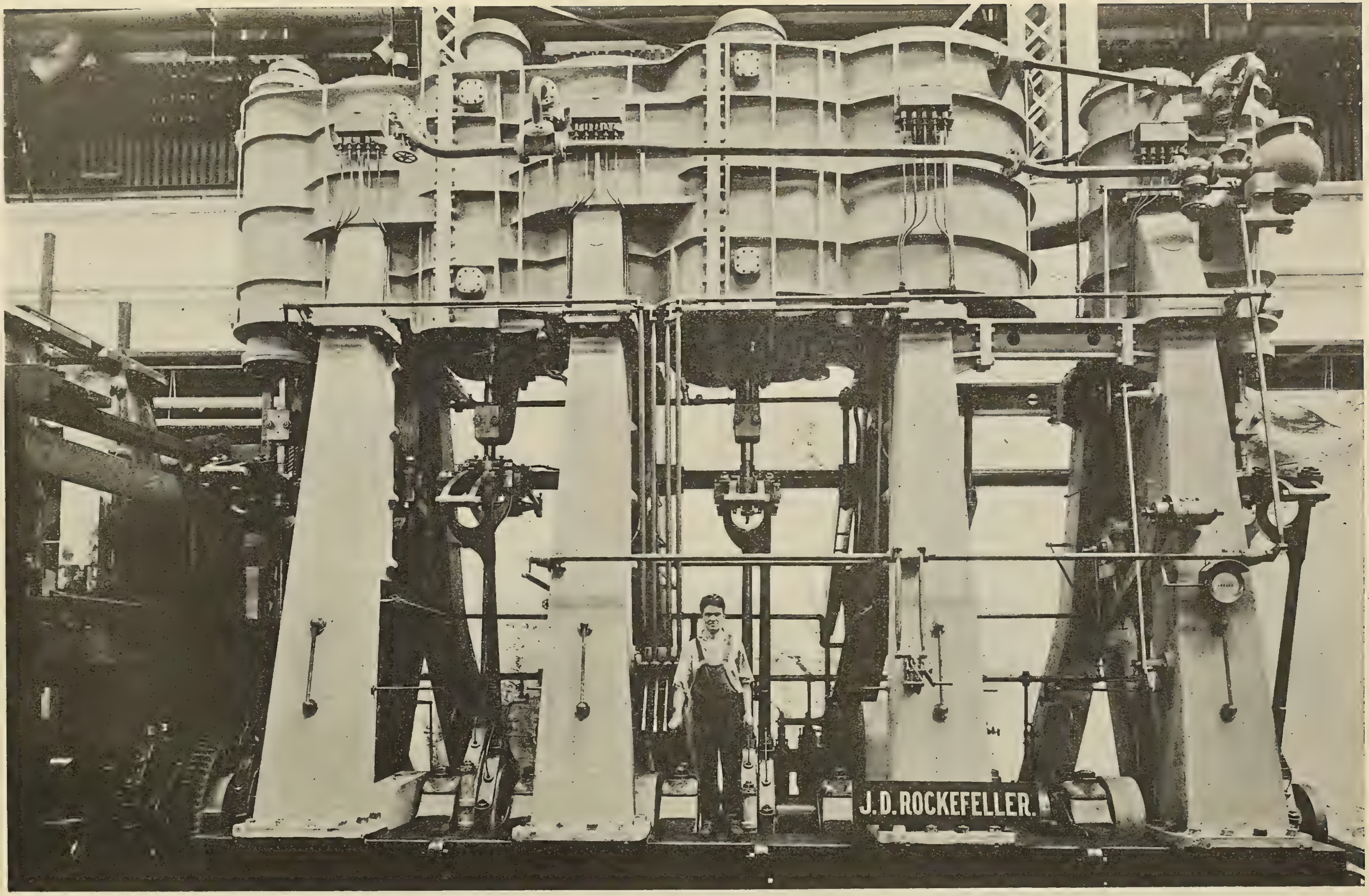


Fig. 21.—Engine Completely Assembled in the Shop and Ready for Disassembling and Installing in the Ship

between centers. The length of the piston rods should be machined to suit conditions of each cylinder.

To arrive at the exact length of a piston rod, a long wooden staff is placed through the center of the cylinder, extending down below the center of the crank shaft. The top, the bottom, the wearing surface of the cylinder, and the position of the cylinder head are all marked accurately on the staff. From the center of the crank shaft, the center of the crank pin is laid out on the staff at the top and bottom of the stroke. From either the top or the bottom center of the crank pin the length of the connecting rod (from center to center) is marked on the staff. Then from the bottom end of the wearing surface, the piston is marked off so the lower edge of the ring is flush with or slightly over the wearing surface. The crosshead is likewise marked off on the staff.

By measuring the distance between the piston and the crosshead, the exact length for machining the piston rod is found (see Fig. 20).

After the machine work on the piston rods and crossheads is finished they are connected up, and the engine turned over by the turning engine and the top and bottom clearances marked on the guide faces. The bottom striking point is found by disconnecting the connecting rod and lowering the piston until it rests on the bottom of the cylinder. This point is on the guide face. The top striking point is found by pushing the piston up against the cylinder head and this point is marked on the guide face.

The procedure in machining pistons and piston rods is to finish the body of the rod, and then fit the piston rod in the piston and turn the piston on the rod. The crosshead end of the piston rod is left long and large, and is not machined to suit the crosshead until the exact length is obtained from work. In machining pistons they are turned to suit the bore of the cylinder, and the grooves for the rings are machined the correct distance from the top and bottom faces of the piston, so that they will positively overrun the wearing surface on the top end and come flush on the bottom. As the engine wears down, the rings will slightly overrun the wearing surface on the bottom end which prevents the formation of shoulders.

The importance of having proper clearances at each end of the cylinders, and of having the rings in their correct positions cannot be too strongly emphasized.

Hanging Radius Links

Valve gear troubles may often be traced to improperly hung radius links. They should never be hung without proving the accuracy of each connecting part.

First: The bore and the turning of the eccentrics must be parallel one with the other.

Second: The facing on the eccentric strap for the foot of the eccentric rod must be parallel with the bore of the strap.

Third: The bore of the upper end of the eccentric rod and the face of its foot must be parallel with each other, and both at right angles to the axis of the rod.

Fourth: The pins in the link bars must be at right angles to the sides of the bars and in line with each other.

This may be termed the A, B, C, of marine engine building. However, the importance of these details requires careful workmanship.

The link bars are first hung to the valve stem, which is clamped central and firmly in the valve-stem guide. The ahead eccentric rod is then connected to the strap on the eccentric, which has had sufficient liners removed between the joints so that it hugs the eccentric snugly, and is swung to the end of the link bar and the distance gaged from the side of the rod to the bar. It is then swung to the other end of the bar and likewise measured. When it shows equidistant at both ends from the side of the rod, the link bars are in their correct position. The go-astern rod is likewise swung in position and given the same test. If both rods show the same result, they may then be connected to the radius links, and the bearings tried by giving the pins a thin coat of red lead and then bolting the caps on hard. They are then disconnected, and the bearings examined. Should they not show a true bearing they are scraped and the same operation repeated until they do.

Setting Valves

When an engine leaves the hands of the builder the valve gear is, generally speaking, correctly adjusted to give the best possible steam distribution compatible with quiet running of the engine at normal speed. However, the effect of wear of the various parts is to disturb the original adjustment, and consequently the valve gear must be readjusted from time to time.

When the keyways in the crank shaft and eccentrics are accurately laid out and machined, valve setting is only a matter of placing the crank on its dead-center position, with the valve gear thrown in full go-ahead position, and measuring the lead. If it is less than specified, the amount necessary to give it the correct lead is faced off the adjusting collar, which supports the valve on the stem, which is left long purposely for adjusting the valve. The crank is then put on the opposite dead center, and the lead for that end measured, which should be correct. Then the valve gear is thrown in full-gear astern with the crank on its dead center, and the leads on the top and bottom ends checked as was done on the go-ahead gear. If the work has been accurately executed, all leads and laps will be as specified on the valve diagram, and such subterfuges as off-set keys and shimming between the eccentric rods and straps by means of liners will not have to be resorted to.

To set a crank on its dead-center position, first set it approximately correct by eye, then with some standard make of engineers' and plumbers' spirit level applied to one edge of the web and adjusted until the glass shows level. The level is then applied to the opposite edge of the web; and should it show a different reading, the crank is rotated slightly until the reading on the level is identical when applied to either edge of the web. This is a quick, accurate method when the crank webs are properly machined.

Should the machining of the crank webs be uncertain the old method may be used, which is as follows:

When the crosshead is a few degrees away from its highest point, a mark is made on the guide slightly above the upper edge of the crosshead. The engine is turned until the upper edge of the crosshead comes even with the mark. While the engine is in this position, place a tram, both ends of which are pointed, with one end in a center-punch mark made in some convenient part of the bedplate or housing, and make a mark with the other end on the face of the crank web, coupling, or turning wheel, whichever may be the most logical place; then turn the engine off center in the other direction until the edge of the crosshead comes even with the mark. The crank pin will now be the same distance to the right of the center as it was to the left in the first place, or vice versa.

It is evident that the marking point of the tram will not be oposite the mark made, but will make a new mark on the face of the web or coupling. Now make another mark half way between the marks already made, and then

turn the crankshaft until the tram point is opposite this mark and the crank is then exactly on its top dead center.

In a similar manner, the crank may be placed on the bottom center. To insure accuracy, the tram should be of such a length that the marking point will be approximately in a plane passing through the axes of the crank shaft and cylinder.

If the keyways in either the crank or the eccentrics are not accurately located, the eccentrics will have to be advanced or retarded until the correct lead is obtained and off-set keys are made and fitted to suit.

It is well to bear in mind that moving the eccentric does only one thing, that is, to retard or advance the lead, while raising or lowering the valve on its stem equalizes its travel.

The scope of this article does not permit of a detailed account involving all of the engine details, such as the reversing engine, turning engine, air pump, governor and hand gear, which must respond with the same certainty as the major unit, but the same principles in machining and erection outlined above are involved in their construction and installation, and must be carefully observed to produce a successful engine. Fig. 21. shows this engine completely erected in the shop and ready for disassembling and installing in the ship. The final installation of the engine will require no further machine work.

Present-Day Types of Heavy Oil Engines; Their Limitations and Possibilities

BY WALLAND

THE heavy oil engine, as we know it to-day, covers a seemingly wide range of forms, but this is not so much due to fundamental differences of principle as to constructional and mechanical differences. The tendency to refer to individual makes of engines by their trade names, and place all in the heavy oil engine class, is a healthy sign, as the fuel situation is such as to force the engine builder to adapt his engine to burn whatever grade of heavy oil happens to be most available. Hence it comes that the main object is to produce an engine which will burn any variety of what is known as fuel oil, no matter what its size or application. In time this condition of affairs ought to tend to reduce the number of cycles of combustion, but as for mechanical details there is bound to be a wide variation of forms, due to the variety of types of installation. The final decision in each case must rest on engineering and economical reasons, and time and experience alone will settle just the exact balance.

Diesel Engines Expensive to Build

The premier heavy oil engine has always been, and is to-day, the Diesel engine. It is the standard by which all others can be judged. It is the most economical, as regards fuel consumption, but the most expensive to build; the very mechanical features which make the engine economical of fuel are the ones which increase its first cost. An effort to reduce the first cost and yet not lose too much in fuel economy was the impelling reason which has given us to-day the other forms of heavy oil engine which we have. But we will first consider the Diesel engine in its various forms and what promise it holds for the future.

The majority of marine Diesel engines in use to-day are of the four-cycle type. Small engines fitted with reverse clutches are built in three, four and six-cylinder sizes, but in order to make an engine directly reversible it is necessary to have at least six cylinders, unless some unusual means are used. More than six, except in the case of very large powers where the size of cylinder is a determining feature, simply adds to the number of parts on the engine and takes up increased length, which is always at a premium, without any corresponding advantage. Moreover, a reduction in the number of cylinders for a given power has a tendency to keep down the revolutions per minute, due to the larger size of cylinders; and this is always an advantage in marine work.

Small Engines Are of Trunk-Piston Type

The smallest sized engines, say up to 600-horsepower, are of the trunk-piston type, with a choice of lubrication between the gravity and forced-feed type. The gravity type has the advantage in regard to the amount of lubricating oil flying around in the crank case, and an excess of this means the formation of an oil fog which will tend to work up by the piston rings and cause a large lubricating oil consumption, if not actual trouble with sticky piston rings and carbon deposits. It has the disadvantage of supplying the bearings with only just the amount of oil they need, or perhaps a little more, and if for any cause there is a sudden warming of any bearing, there is no surplus of oil immediately available to take care of the difficulty. It is a fact that with forced lubrication, even with a moderate amount of oil supplied, bearing troubles are very few and far between. With proper piston rings and a good wiper ring at the bottom of the piston, with drain holes to carry off the surplus oil scraped from the cylinder wall, there is, after all, not much trouble due to surplus lubricating oil, and the forced lubrication system has consequently found high favor among engine builders and operators.

There is one important point to be watched, however, and this applies equally well to both systems of lubrication, and that is the pollution of the lubricating oil by carbon from the cylinder walls. This is a disease common to all internal combustion engines where the lower end of the cylinder is open to the crank case, and simply means that from time to time the lubricating oil must be filtered or passed through a centrifugal separator so as to get rid of this carbon.

There is another question which needs to be considered seriously for the small engines, and that is the question of reverse clutches versus reversible engines. A reverse clutch has all the advantages as regards operation except in the rare case of where an engine backs for hours at a time. In this case the clutch gets very hot even though of rugged dimensions. But under ordinary circumstances, with a clutch, the boat can be maneuvered as often as

desired without any expenditure of starting air, and every one knows, or at least ought to know, that high pressure compressed air on board ship is expensive. Consequently we find that engines are fitted with reverse clutches up to the size where the loads to be transmitted make the clutch unwieldly and more expensive than the reverse gear on the engine, plus the extra air tanks or flasks and other equipment required for a directly reversible engine. The dividing line seems to be between 200 and 300 horsepower, although we find occasional instances of larger engines fitted with reverse clutches or reversing propellers. But if an engine builder is going to fit a reverse clutch on an engine, let him by all means fit one worthy of the name—not a puny, weak affair, but a clutch which will last as long as the engine does with a reasonable amount of overhauling. Pacific coast gas engine builders have established a good precedent in this regard.

Large Four-Cycle Diesels of Crosshead Type

Four-cycle Diesel engines of large powers are pretty well standardized. The majority are of the crosshead type with enclosed crankcase separated entirely from the working cylinders, and fitted with forced lubrication on the principal bearings. There is nothing to contaminate the lubricating oil under these conditions, and it can be used over and over again for a long time with nothing more done than the addition of a little makeup oil. Bearing troubles are practically unknown, and the operator need have no fear because the bearings are enclosed and he cannot see and feel of them. There is only one possible chance of trouble, and that is in the case of leakage of salt water into the lubricating oil, but the engine builder does his part by carefully designing the crank case enclosure, and then the same care must be shown when installing the sump tank in the ship. With a carefully designed and executed installation, most of the trouble in this direction can be eliminated, and it is an important point which needs to be watched in every installation.

There is a growing tendency on the part of engine builders to provide greater simplicity and accessibility. This not only tends to keep down the first cost, but provides for better operation. Nobody can appreciate accessibility better than the operating engineer.

One other point, which is getting more and more attention and yet cannot get too much, is the question of easy and cheap renewal of parts subject to wear. Nowadays, the purchaser of a motorship not only expects the engine to run, but he also expects the engine to last as long as the ship, the same as the steam engine does, with only the usual overhauling. The shipowner has a right to this character of service, and it can be provided without difficulty in a properly designed engine. Let every engine purchased be examined from this standpoint.

Future Development of the Four-Cycle Engine

As for future developments and improvements in the four-cycle Diesel engine, we can expect but little, except perhaps, further perfection of some of the mechanical details. It is a reliable machine, but very heavy and costly. About 325 shaft horsepower per cylinder is the upper limit of size of any engine in service to-day, and while this covers the requirements of practically all cargo ships, especially when installed with twin screws, yet no one supposes that the development of the oil engine is going to stop there. The tendency is towards larger and faster ships, especially in the case of motorships where the extra speed costs so little, and all this means more power. Therefore, the future will require higher powered engines designed on smaller weight and space allowances, and for a lower first cost. On this basis the single-acting four-cycle engine must give way at least for the large powers; it will probably have a field of its own, however, in the moderate powers.

The Two-Cycle Engine

There are very few two-cycle Diesel engines in use in motorships to-day, but this is rather the result of circumstances than otherwise. This type has many advantages for marine purposes, and in the early days of the application of the Diesel engine to the marine field several firms undertook, with very little or no previous experience, to build large engines of this type. The result was that several of the engines were failures. It does take more skill to design a two-cycle engine than a four-cycle engine, because of the more intense heat conditions in the cylinders and the constant downward pressure on the bearings, but with these difficulties overcome by the use of suitable materials and careful design the two-cycle engine looks very attractive. That these difficulties can be overcome is shown by the successful operation of some engines of this type, built by certain firms of extensive experience.

Let us examine the two-cycle engine as compared with the four-cycle for a moment. As already stated, the four-cycle engine is usually built in six cylinders to gain ready reversibility. Now turn this engine into a two-cycle by changing four of the working cylinders appropriately. The new engine will have four impulses per revolution instead of three; hence a smoother turning moment. The cranks will be at 90 degrees instead of 120 degrees; hence better maneuvering ability. Taking the total power of the four-cycle engine as 1, then the power of the two-cycle will be about 1.2, because the mean effective pressure of the two-cycle engine is about 10 percent less than that for the four-cycle engine. But we need a scavenger pump, so we will fit it in place of the other two working cylinders. It will supply four working cylinders, and ought to have 50 percent more displacement than the working cylinders, so that, if we make the pump double acting and the same stroke as the working cylinders, the diameter will be about 1¾ times the working cylinder diameter. This pump will naturally not take up so much room as the two working cylinders, nor so much weight. The air compressor will need to be a little larger for the two-cycle engine, but the increase in space and weight required will be only a small percentage of the total. The net result of this change, then, is an engine of the same cylinder size and revolutions as before, but developing 20 percent more power on less space and weight. Is it any wonder that the two-cycle engine has so many followers?

The two-cycle engine has a fuel consumption about 5 percent higher than the four-cycle engine. On the other hand it is simpler mechanically, particularly in connection with the reversing gear details. Engines of 500 and 600 shaft horsepower per cylinder are in successful operation to-day, so that this type offers much larger powers than any other which is immediately available.

Possible Mechanical Changes

What is needed, however, is not higher-powered engines, but engines which are simpler and cheaper than our present-day types. There are two methods of attacking the problem—one is by a change in mechanical arrangement, and the other is by a change in principle, with the resulting change in mechanical arrangement.

The two best examples of a change in mechanical arrangement are the opposed piston or Junkers type of engine, and the double-acting engine. The opposed piston

type is excellent as regards balance, small weight and space, absence of valves and ease and thoroughness of scavenging, but the mechanical arrangements for getting the power from the piston to the crankshaft and for cooling the pistons are not so attractive. A few firms have undertaken to develop this type of engine and claim great success with it, but in general it has found very little favor. The double-acting engine, on the other hand, offers many advantages without leading into any awkward mechanical difficulties.

It is possible to build a double-acting four-cycle engine, and in fact a certain firm in Germany attained quite a reputation with its tandem double-acting four-cycle engine several years ago, but these were of the horizontal stationary type. It is not likely that an engine of this type would be attempted for marine purposes because of inaccessibility and an awkward arrangement of valve gear. A double-acting four-cycle engine with one cylinder per crank is possible, but compared with a double-acting two-cycle is so unattractive mechanically that probably this type also would be abandoned in favor of the latter.

The two-cycle double-acting engine is everything that a reciprocating steam engine can be for turning movement, balance, maneuvering ability, and more, since each end of each cylinder is a complete power plant in itself. This type can readily be built in anything from two cylinders upwards. There is a positive reversal of pressure on all bearings, which should eliminate all trouble in this direction, no matter what particular system of lubrication is adopted. Almost twice as much power can be developed at a slight increase of space and weight as compared with the single-acting engine of the same number and size of cylinders, or a better solution is to reduce the number of cranks, which naturally tends to increase the size of cylinders and reduce the revolutions per minute.

All these advantages offer considerable incentive for the development of such an engine, and some progress has been made. Germany produced such a machine, after several years' experimental work, in 1914, but what has happened since then we do not know. Several other firms in other countries have also done considerable experimental work. Some of the problems, such as the piston rod stuffing box, have been solved, but the best arrangement of combustion chamber, valve gear, and design of cylinder and piston must be worked out in the light of extensive experience. This type of engine offers such attractive possibilities that it looks like one of the engines of the future.

Possible Changes in Principle of Operation

A good example of an engine simplified by a change in principle is the so-called solid injection type. This type of engine omits the air compressor for supplying compressed air for atomizing the fuel, and depends upon a high pressure and a special form of nozzle to accomplish the same purpose. In England such an engine has been developed employing the same cycle of combustion and duplicating the ordinary Diesel engine mechanically except for the omission of the air compressor and some slight changes in the fuel system. In this country, an engine working on the Otto cycle with a compression pressure of about 200 pounds per square inch, and a maximum pressure of from 400 to 500 pounds per square inch, has been developed and is now being built by several companies. Both designs are of the four-cycle type. They show as good or better fuel economy and develop as much power for a given size of cylinder as the ordinary four-cycle Diesel engine. Consequently they show a distinct saving in weight and space, and ought to be cheaper in first cost. To date they have not been built in very large powers per cylinder, 100 shaft horsepower being the limit in this direction, but this type is comparatively new and there is no reason so far as the principle is concerned why it cannot be built in the same sizes as a Diesel engine.

Mechanically, this type does not offer much simplification, since the working cylinder details follow the Diesel engine very closely. They have to be made reversible for marine purposes, of course, and a reversible four-cycle engine is not particularly attractive mechanically. To be sure, they are made to work, and very reliably too, but the large number of parts required for the purpose are a constant inducement to all engine designers to try and accomplish the same result in another and simpler way. However, this type is an advance, and offers much for the future.

Surface Ignition Engines

There is another type of solid injection engine which is in an entirely different class and goes under another name, that is, the surface ignition type. It was first built a good many years ago, and to-day has become thoroughly standardized. The typical engine is of the two-cycle port scavenging type, with the lower side of the working piston and the crank case acting as a scavenger pump. It works on the Otto cycle, and since the low compression does not give heat enough for ignition of the fuel some auxiliary means, as a hot tube, bulb, or coil, is necessary.

It is about the simplest and cheapest of oil engines that can be conceived, but its virtues end with that statement. The scavenging is poor, principally because the displacement of the scavenger pump is only equal to the volume of the working cylinder. Furthermore, the hot bulb generally forms a pocket by iteself which is not readily scavenged, due to its shape. All this means that there is a lack of pure air in the combustion space at the end of compression, and if the air is not available the fuel cannot be burned. These engines develop only from 40 to 50 percent as much power in a given size cylinder as does the ordinary two-cycle Diesel engine. Of course, this naturally means that for a given power the cylinders must be large and the engine correspondingly heavy. The fuel consumption is at best a third more than for a Diesel engine.

The lubricating oil consumption is also very high, due to the use of the crank case as a scavenger pump. Any surplus oil from the crank or wrist pins, and there must always be some surplus in order to avoid burned-out bearings, is picked up by the scavenging air which is always rushing through the crank case, and some of it at least is carried up into the working cylinder and lost. Modern designs fit special devices on the main bearings to prevent loss of lubricating oil from them, so that the lubricating oil consumption has been reduced to some extent.

Let it not be thought from this that the surface ignition engine is to be universally condemned. It has a place, but the size of that place is limited. Most engines of this type are of small powers and the requirements of most such cases call for reliability and low first cost. The surface ignition engine meets these without difficulty. Its very simplicity makes it reliable and low in first cost. Its comparatively large weight for the power is mostly cast iron, and is taken care of in the foundry. As far as the installation is concerned the extra weight is no objection. The total amount of fuel consumed and its low price make the fuel bill moderate, so that its relatively high fuel consumption is not a seriously objectionable point. The question of lubricating oil consumption is different, and unless the design of the engine is such as to keep this within

reasonable limits it may make the difference between success and failure.

Surface ignition engines are offered for sale in sizes up to 125 shaft horsepower per cylinder. Some builders use reverse clutches for all sizes, others make all sizes directly reversible, while others steer a middle course, making the larger sizes directly reversible and using reverse clutches on the smaller sizes. This type of engine can be made reversible very easily, and it would seem to be the better way for the larger sizes where the reverse clutch begins to assume undue proportions. The real field for the surface ignition engine is in the small powers. It does not offer much chance for improvement because of the principles of its design; and if these are changed, then it will no longer be the simple, cheap engine it is to-day.

An Improved Surface Ignition Engine

There is an engine built on the Pacific coast which falls in the general class of surface ignition engines, but which has been so changed in principle and mechanical detail that it deserves separate attention. It has been built in only one cylinder size of about 100 shaft horsepower to date. Both four-and six-cylinder engines have been built, and they are made directly reversible. It is of the two-cycle, port scavenging type, and is fitted with crossheads and an open frame. The lower end of the cylinder is enclosed and is used as a scavenger pump. In addition there are double-acting scavenger pumps on the back of the engine. These latter pumps are driven from the working cylinder crossheads by the ordinary beams and links. The important point, however, is these extra scavenger pumps which provide more air for the working cylinders. The result is an increase of about 30 percent in the power developed as compared with the ordinary surface ignition type, with the same size of cylinder.

As already mentioned, this engine has an open frame and is fitted with crossheads. Drip lubrication is used, and in fact the lower part of the engine looks exactly like a great many marine steam engines. This brings the engine nearer to established marine practice; and with the increase in power gained at the comparatively slight expense of additional scavenger pumps, this type marks a distinct advance. Note that the modified construction avoids the heavy lubricating oil consumption of the ordinary surface ignition type. It is a cheap design of engine to build, and has all of the virtues and few of the faults of the ordinary type. While it offers some chance for improvement in mechanical details and in principle of combustion, there is a limit to the latter, and in this respect it is in much the same position as its prototype. That is to say, if the principle of its operation is changed in a marked manner in order to reduce the fuel consumption or increase the power per cylinder size, it will lose much of its simplicity and attractive characteristics.

The Hvid Engine

There is another type of engine which has only recently come into prominence, but which promises to be a very serious competitor of the surface ignition type, and that is the Hvid. It is of the four-cycle type; uses the same compression as the Diesel, and without the necessity of an air compressor or high pressure fuel pump burns the same fuel with as good an economy. A needle valve controls the amount of fuel which flows into a cup in the cylinder which controls the combustion. It develops as much power per cylinder size as a four-cycle Diesel engine, and except for the fuel valve and cup the mechanical design follows the general lines of the Diesel more than any other type. It is available to-day, however, only in comparatively small sizes, about 25 shaft horsepower per cylinder being the limit. It has been standardized in design by several builders and is an appreciably cheaper engine to manufacture than the Diesel engine, although more costly than the surface ignition type. The small powers in which it is built make the reverse clutch not only available, but very attractive; and hence it has been neither necessary nor desirable to develop a directly reversible engine. This type of engine is also very satisfactory for use as an auxiliary generator engine on board motorships. It uses the same fuel as the main engines with as good economy, it is readily governed, and is cheap to manufacture.

It offers little opportunity for development of the principles of combustion; but this is no disadvantage, since it is already as good as the best. There is little room for improvement mechanically, since here again it has reached a high state of development. The greatest chance for advancement seems to lie in the application of this principle to larger cylinder sizes, especially for auxiliary generator work, and in the application of this engine to marine work in general in substitution for other types.

Possibilities of the Gasifier

There is still another type of engine which has only very recently been introduced into this country, and which consists of a so-called gasifier that can be applied to either a two- or four-cycle engine. The engine, aside from the gasifier, follows the usual lines of construction. This gasifier is a chamber attached to the cylinder, and the fuel is first injected into it, where a slight explosion takes place, which drives the main body of the fuel into the cylinder. The same high compression, about 500 pounds per square inch, is used as in the Diesel engines, and the same variety of fuels can be used with as good an economy. The power developed per cylinder size is not as much as in the Diesel, but is more than in the surface ignition type. To-day, this type is built in this country in very small powers only, up to about 15 shaft horsepower per cylinder, and all of the engines are of the two-cycle type. Its simplicity of operation, its excellent economy, and its fair mean effective pressure make it very attractive. Comparatively speaking, it is only in the early stages of its development, and what its future will be, time alone can tell, but it certainly looks as though it had possibilities.

Conclusions

In conclusion, let us view the field broadly, first taking up the general requirements for marine heavy oil engines for all services, and second, examine the several types available for these services.

Every marine engine must be reliable, and if it is not reliable, then no matter what other virtues it may possess, it is useless for marine purposes. The quality of being reliable covers not only the absence of mechanical breakdowns but also perfect combustion, which will remain perfect over very long periods of operation. Fuel valves, which will clog up for any reason, or imperfect combustion, which results in carbon deposits or pitting of valves, are conditions which cannot be tolerated. The marine heavy oil engine must be adapted to burn a fairly wide variety of fuels with little or no change in adjustment, and with perfect combustion results, since a motorship trades all over the world, buys its fuel in the best available market and the characteristics of fuel oil change according to the oil field from which it is obtained.

Accessibility for the parts which need inspection or adjustment is almost as important as reliability, for no man will give an engine proper attention if an extraordinary amount of work is necessary. The engine must be reasonable in first cost, or it will take too long for the economy it will show over a steam installation to pay for

the difference. plus the extra fixed charges. The parts which will wear must be capable of ready and cheap replacement in order to keep down the cost of repairs. This is increasingly important as the size of engine increases. The engine must be simple enough in design, so that the average engine operator can understand the functions and the necessary adjustments of the various parts without difficulty. The design must be rugged enough so that the engine can stand a reasonable amount of abuse. Of course, any piece of machinery ought to be operated properly at all times, but the fact remains that the contrary sometimes happens, and so far as possible the design should be such as to minimize the evil results from this.

Marine heavy oil engine service can be divided into two general classes, propulsion and auxiliary generator. For propulsion purposes, with powers not exceeding about 50 shaft horsepower, we have available to choose from, engines of the surface ignition, Hvid, and gasifier type. Nearly all of the engines of this power are fitted with reverse clutches and most of them require compressed air for starting. Some of the very small sizes, however, are arranged to be started by hand. The surface ignition type is the oldest, and hence there are more manufacturers of this type than the other two, but the advantages of the other two types are sufficient to warrant a careful investigation by the purchaser before plunging too heavily into engines of this size.

For engines from 50 to 100 shaft horsepower, we have a choice of the surface ignition, Hvid, and Diesel types, Most of these engines have reverse clutches, some of the surface ignition engines being directly reversible, and all require compressed air for starting. A Diesel engine in this size is so expensive and the advantages over the other two types are so slight that it is not a serious competitor commercially. In this size, again, the surface ignition engine is manufactured so widely that it almost has the field to itself, but the Hvid type has made a start and ought, in time, to get more attention.

The next step in size is from 100 to about 600 shaft horsepower. Here the choice narrows to the surface ignition and Diesel types. The Diesel engine in this power is generally of the four-cycle trunk piston type and does not require any special piston-cooling arrangements. Within this range the dividing line is reached between reverse gears and directly reversible engines. The nearer the upper limit of this range of power is approached, the more the advantages of the Diesel engine are apparent, and it may be said that in reality the surface ignition engine is a competitor of the Diesel only over the lower part of the range from 100 to 600 shaft horsepower. The solid injection type also enters the upper part of this range of power, but this can be regarded more as a simplified form of Diesel than anything else.

For powers over 600 shaft horsepower the Diesel type in some form has the field to itself. It is a question of either two or four cycle, with the two cycle in favor as the power increases. Beyond this comes perhaps the double-acting engine, but this is in the future. All engines of this size have crossheads and conform to established marine practice.

For auxiliary generator service, the requirements call for a stationary type engine with a maximum power of about 200 shaft horsepower. Most of the engines of this type, however, are of very much less power, and this opens a field for the Hvid type of engine. A few engines of this type have been fitted, but the majority have been of the four-cycle Diesel type. There is also a need for a small emergency engine of about 5 to 10 shaft horsepower, which can be started by hand. A surface ignition engine of this size connected to a generator would be most useful. It could furnish power for a small compressor to supply starting air in case the regular supply became completely exhausted from any cause; it could supply power for the wireless, even if all other power on the ship were lost; and it could supply lights, and even some power for regular service when the ship is in port, and it is not necessary or desirable to run one of the regular generator sets.

What is the general tendency in heavy oil engine design? The general tendency is always towards a simpler and cheaper engine without sacrificing other advantages too much. There probably will be modifications of the combustion cycles used to-day, and these will involve changes in mechanical details, but the main idea back of them all will be the same. Time and experience under actual working conditions, and not laboratory tests, can alone settle the best balance and determine the best type for a given set of conditions.

Development of American Motorships

TO the American-Hawaiian Steamship Company of New York belongs the credit of departing from the beaten path of American experiments in small motor vessels, by ordering two freighters of 11,200 tons deadweight capacity, powered with two Burmeister and Wain type Diesel engines, having an indicated horsepower of 4,500. The ships will be about 460 feet long and will be built at the Chester, Pa., yards of the Merchant Shipbuilding Corporation. The engines will be built by the William Cramp & Sons Ship and Engine Building Company, Philadelphia.

Pacific Coast shipyards are also rapidly developing in motorship construction. Pursuing the policy of expanding its fleet of motorships, the Standard Oil Company of California has recently placed contracts with the Moore Shipbuilding Company, Oakland, Cal., to build a tanker of 5,010 tons deadweight capacity and 2,000 indicated horsepower. The main propelling machinery will consist of two Werkspoor engines, which are being built by the Skandia Pacific Oil Engine Company, Oakland, Cal.

In addition to the motorships under construction in the United States, firms developing marine Diesel oil engines of various types are preparing for a demand for units of higher power by building engines up to 2,300 horsepower. The Skandia Oil Engine Company is carrying on the construction of twenty-five 850-1,000 brake-horsepower Werkspoor oil engines. At the Fore River plant of the Bethlehem Shipbuilding Corporation experiments are also being conducted on high-power machines.

McIntosh & Seymour, Auburn, N. Y., James Craig Engineering and Machine Works, Jersey City, N. J., and the Worthington Pump & Machinery Corporation, New York, are all building four-cycle Diesel type engines of about 2,000 horsepower.

Although the two-cycle Diesel engine has certain features to recommend its trial in American ships, the Busch-Sulzer Bros. Diesel Engine Company, St. Louis, Mo., is the only firm at present building high-powered units of this type. The largest of these now under construction is of 2,300 horsepower.

A Review of Motorship and Marine Diesel Engine Building in Europe

BY OUR SPECIAL LONDON CORRESPONDENT

THE first large motorship was put into commission in the early part of 1912, so that before the outbreak of war there was comparatively little time for any widespread development to be made in Europe. While the war was in progress none of the shipbuilders in the belligerent countries was able to devote much attention to this phase of shipbuilding and work was necessarily held up in the neutral countries, owing to the shortage of material and other circumstances connected with the war. The result was that by the time the armistice was declared motorships had not come to the fore as much as they might have done under other conditions. The events of the past year have, however, proved that the claims made for the motor vessel are fully justified, and the very large numbers of orders that have been placed, in many cases by owners of existing motorships, demonstrate that complete confidence is placed in this new type of vessel.

Motorships Building Total Nearly 1,000,000 Tons

There are at the present time between 110 and 120 motorships on order in European shipyards, the majority of them having a deadweight capacity of about 10,000 tons each. The total deadweight carrying capacity of these vessels is between 900,000 and 1,000,000 tons, while the power of the machinery installed is in the neighborhood of 300,000 indicated horsepower.

These figures, large as they are, represent only comparatively a small proportion of the motor vessels that could be contracted for, if it were possible to obtain reasonable deliveries. The chief difficulty which is now encountered is that every marine oil-engine manufacturing firm in Great Britain or on the Continent, which has had any prolonged experience in this work, is so fully occupied that it is impossible to carry out any more work or give deliveries within the next year or eighteen months. Every effort is being made to cope with the demands and new factories, specially equipped for Diesel engine manufacture, are being erected by some of the oldest established shipbuilders. It is particularly interesting to note that the leading firms on the Clyde are making a very strenuous effort to overtake the Scandinavian shipbuilders who have gained such a considerable lead in this industry, owing to their enterprise in embarking upon a policy of marine oil-engine manufacture at a time when most shipowners and shipbuilders looked askance at this new departure.

An idea of the relative position in the motor shipbuilding world can be gaged from the fact that of the motor vessels mentioned above, 40 are on order in Denmark, 22 in Great Britain, 20 in Sweden and 13 in Holland. France is, however, making little headway and details are not yet available regarding the work which is being carried out or is contemplated in Germany. It is stated, however, that the Germans intend rebuilding their mercantile fleet, practically entirely with motor vessels; and when it is remembered that before the war German engineers had perhaps gone as far as those in any other countries in marine oil-engine development, it will not be surprising if considerable progress is made in Germany when things become more settled in that country.

One of the most notable features in connection with the development of the motorship is a very definite tendency towards standardization among shipbuilders and shipowners. It will readily be understood that this type of ship lends itself specially to construction of large numbers of exactly the same type mainly for the reason that the machinery can easily be standardized, thus costing much less to build and being capable of manufacture in a considerably shorter time. The shipowner, too, realizes the advantage of having several ships in which the machinery is duplicated, since this avoids the necessity of having large numbers of spare parts and at the same time diminishes the risk of breakdown.

Standardization of Motor Vessels

It will be interesting to examine the three main classes of motorships which may be said to represent the standard types of vessel now being constructed in Europe, and which as a matter of fact account for quite 90 percent of the internal combustion engined ships now under construction. In the first place there is the largest type of all, with a deadweight carrying capacity of 13,000 to 13,500 tons, 465 feet in length, with a beam of 60 feet and a draft of 31 feet 6 inches. Over 20 of these vessels have been contracted for in Great Britain and Scandinavia; but while in the latter countries the machinery power comprises two sets of 2,250 horsepower, the British ships are fitted with machinery of the highest-powered Diesel motors yet built, these being two 3,200 horsepower sets, giving the vessel a speed of about 13½ knots. It is distinctly to be noted that owners of motorships are more and more tending to increase the speed of these vessels, by installing high-power machinery. Quite the majority of motor vessels now being built are designed to develop a speed of 11½ to 12 knots, and many of 13½ to 14 knots. One of the reasons is that the fuel consumption in these vessels, as compared with a coal-fired steamer, is so small that the great disadvantage of the average high-speed cargo steamer, namely, high fuel costs, scarcely enters when the vessel is propelled by internal combustion engines.

The second type of standard vessel is one carrying from 9,500 to 10,000 tons of cargo, 425 feet in length, with a beam of 56 feet and a draft of about 25 feet 6 inches. In nearly all these vessels, two six-cylinder engines of about 1,500 brake horsepower are installed for a designed speed of 11½ to 12 knots, and many shipowners consider this class to be the most successful and economical for the general carrying trade especially on very long voyages. It is significant in this connection to note that the three shipowning firms with the greatest experience in running motor vessels have many of these 9,500-ton ships on order, the concerns in question being the Glen Line in Great Britain, the East Asiatic Company in Denmark, and the Johnson Line in Sweden.

The third standard vessel is a 6,500-ton deadweight carrying craft, 367 feet in length, with a beam of 57 feet and a draft of 25 feet, generally equipped with two 1,000 indicated horsepower Diesel engines, which give a speed of about 11½ knots. This class of ships has also proved extremely economical in service and is in fact the most popular among shipowners who, for one reason or another, do not care for the larger sizes. Actually there are more 6,500-ton motorships on order than of any other

type and Norwegian shipowners in particular place great faith in such vessels. It has been shown in the course of many years of service that such a motorship equipped with two 1,000 horsepower engines, having a speed at sea of over 11 knots, will operate regularly on a fuel consumption rather lower than seven tons of oil per day of 24 hours. As these ships are generally designed with a bunker capacity of 1,000 tons of oil they can take on fuel at the cheapest ports and practically be independent of other stations, no matter how long the voyage may be.

Types of Engines

One of the most noteworthy points in motorship construction is the success achieved by the four-cycle type of engine. In more than four-fifths of the vessels already built and those under construction this design has been adopted, and on the whole it has certainly proved more reliable in actual service than the majority of the two-cycle engines. It must not be supposed, however, that European ship and engine builders have lost faith in the two-stroke motor; for, on the contrary, some of the most remarkable developments are now being made in connection with engines of this design. So much more experience has been obtained with four-cycle engines that they have gained a lead which it will take some years for the two-cycle engine builder to make up; but there are such obvious theoretical advantages in engines of the latter type that should all the practical difficulties be thoroughly overcome it is not unlikely that such motors would become more generally used than other types. The demand for higher powers may also lead towards this end, for while the four-cycle engine has with some difficulty been gradually built up until engines of 3,000 indicated horsepower can be constructed, two-cycle motors of over 4,000 brake-horsepower have been manufactured for stationary work and one of the leading Diesel engine manufacturing firms in Europe is prepared to build 6,000 brake-horsepower two-cycle engines, under guarantee, and it is doubtful whether four-cycle engines can reach this power in the near future.

Dealing first with four-cycle engines, practically only three types have made any headway in Europe, these being the Burmeister and Wain, developed by the firm of this name at Copenhagen; the Werkspoor, built in Holland by the Werkspoor Company, and the Vickers engine, which has been so widely used in connection with installations in submarines for the British and other navies. As is well known, the former was the first large marine engine to be produced, and in the pioneer motorship *Selandia* two eight-cylinder engines of this design developing 1,000 indicated horsepower were installed. This gave a specific power of 125 horsepower per cylinder and now motors of the same type are being built in Great Britain by Harland and Wolff of 3,200 indicated horsepower in eight cylinders or 400 indicated horsepower per cylinder. It will be noted therefore that considerable development has been made in the intervening years, and it is believed that engines up to 5,000 indicated horsepower can be constructed in the near future to the same design.

More than half the motorships now being built will have Burmeister and Wain engines installed, and it is particularly noteworthy that, apart from comparatively minor modifications, there are no differences in the construction in essential features as compared with the first engines put into commission. One of the chief differences is perhaps the universal adoption of a self-contained three-stage high pressure air compressor on each engine for the injection air for the fuel, since in the earlier types only a single-stage high pressure air compressor was fitted taking air at about 220 pounds per square inch from an auxiliary compressor situated in the engine room driven by a separate oil engine. This arrangement has proved fairly satisfactory, but there is little doubt that the self-contained engine offers greater advantages.

Another change in the design is in connection with the supports for the cylinders, which are now partially carried on steel columns in the larger engines and not wholly on the cast-iron framework as in the earlier types. Moreover, a lantern piece is interposed between the bottom of the cylinder and the framing through which the piston rod can be seen and which also serves for the collection of any lubricating oil dropping down from the cylinders so that it does not fall into the crank chamber. All the other important features in the engine remain the same as in the 1912 type, and it must be admitted that this is very creditable to the original designers. The reversing system has proved so entirely satisfactory that it has never been touched and in ships operating with engines of this type reversing is carried out within five or six seconds and years of service have proved that motorships can thus be handled much more readily and with greater safety than steamers of the same size.

The two other leading types of four-cycle engines, namely the Werkspoor and the Vickers, have both shown distinct developments since the conclusion of the war. In the case of the first-named engine, improved methods of reversing have been devised, but the most important progress has been effected in the increase in the size of engines constructed. Motors are now being built of this design developing 2,140 horsepower, and designs are prepared for 4,000 indicated horsepower sets, although hitherto the largest size has been about 1,300 horsepower. This is an indication of the greater confidence which is being gained in marine oil-engine construction, and these engines of 2,140 horsepower are of the six-cylinder type with cylinder diameters of 26 inches. At present the largest size of cylinder operating on the four-cycle principle has been built by Harland and Wolff, in which the cylinder diameter is 29 inches. It is difficult to say how far this can be increased without involving insuperable cooling difficulties, but most designers believe that sizes up to 35 inches are possible. In this connection it may be noted that the design of the Werkspoor cylinders is different from that adopted by Burmeister and Wain, in that cylinders are arranged in pairs of three, each unit being contained in what is virtually a water tank forming the jacket with the liners fitted separately into this tank.

Solid Injection Diesel Engines

The modification of the Vickers engine to render it suitable for mercantile ships is perhaps one of the most important developments in Diesel engine construction in England. In essential operation, the Vickers engines for cargo ships are similar to those installed in a very large number of submarines, and the manufacturers are so confident of their solid injection system of fuel that they are employing it on every class of engine now being built. They have converted their submarine-engine shop into a factory for constructing slow-speed mercantile engines and numerous motors are now being built. The oil pressure at which a solid injection system works is over 4,000 pounds per square inch, and one of the most remarkable facts in connection with this arrangement is the low fuel consumption which is obtained, for figures below 0.4 pound per brake-horsepower-hour have been reached.

At present the largest engines being constructed for actual service are 1,250 brake-horsepower, six-cylinder sets with cylinders 24½ inches diameter and 39 inches stroke, but some very big experimental engines are now under construction at the maker's works, and it may be possible to give details of these at a later date.

Two-Stroke Engines

From the purely engineering point of view the work which has been carried out in Great Britain and on the Continent on two-cycle marine engines is, perhaps, of the greatest importance. When it is borne in mind that some of the most renowned shipbuilders in the country are now busily occupied in developing two-cycle motors it may well be realized that the supremacy of the four-cycle engine is likely to be seriously challenged in the course of the next few years. For it cannot be denied that once the two-cycle engine gains an equal reputation for reliability to that which is now enjoyed by the four-cycle the advantages of the former in the matter of reduced weight, lower initial cost and smaller space occupied cannot fail to have an influence upon the minds of shipowners and superintendent engineers. Even in the question of fuel consumption the four-cycle engine will scarcely show to any advantage; for, in the latest types of marine Diesel engine of the Sulzer construction, fuel consumptions of 0.41 pound per brake-horsepower-hour have been reached, which is only three or four percent above those of the most economical four-cycle engines.

This Sulzer engine, which has been considerably modified during the past year or two, offers one of the most likely solutions of the problem as the application of two-cycle engines to ships; and it is especially interesting to record that its manufacture has been taken up in England by Armstrong, Whitworth and Company, Ltd., who since the conversion of their naval yard to mercantile shipbuilding work probably possess the best facilities in the whole of Europe for turning out a large number of hulls.

There is scarcely any question in the minds of European designers that the successful two-cycle engine must be of the valveless type. This principle has been adopted in the Sulzer engine for many years, but in the latest design (of which several sets have recently been completed for installation in Danish and Norwegian ships) some novel arrangements have been adopted. As is perhaps well known, the general principle of scavenging in these engines lies in the provision of two sets of scavenging ports, one above the other, close to the bottom of the cylinder and opposite the exhaust ports. The bottom row of ports is uncovered by the piston in the course of its stroke, admitting scavenging air at about 1½ pounds per square inch, but during this period the top row of scavenging ports does not admit scavenging air, as the inlet is closed by a semi-rotary valve. Just before the bottom row of scavenging ports is closed by the piston on its upward stroke, this rotary valve is opened and admits an excess supply of scavenging air to the cylinders, thus thoroughly cleansing out the whole of the cylinder of exhaust gases and filling it with pure air for the compression stroke. Originally a double-beat valve was employed for this purpose; but the rotary valve is found to be a great improvement and there is little trouble that can be experienced with it in connection with leaking, since it is never exposed to a high temperature.

Another important modification that is being adopted in the new Sulzer-engined ships is that instead of driving the scavenging pumps direct off the engine, as has been done in previous types, these pumps are entirely separate and are driven by means of electric motors, being themselves of the turbo-blower type.

The advantage of this is that the engine is shortened and an increased efficiency of scavenging is obtained, while the scavenging pressure and the quantity of scavenging air can be varied according to circumstances; while at starting the engine can be warmed by heating the scavenging air before admission to the cylinders. This is an entirely novel departure in motorship practice, and is one that will be watched with the greatest interest by motorship engineers.

Some Novel Designs

Of the other types of two-cycle engines that have made great strides during the past year, none is more interesting than the two opposed piston designs developed respectively by Cammell Laird, of Birkenhead, and Doxfords, at Sunderland. The former is so fully described elsewhere in this journal that there is no need to repeat the details of its construction except to remark that the first ship in which one of the motors is installed has just been completed and another vessel with two larger engines developing 1,000 brake-horsepower is almost ready for its trials.

The Doxford engine, in a way, inaugurates a new phase of motorship construction, since the builders have already standardized a certain type of engine for installation in single-screw motor cargo ships, which are themselves also standardized. The novelty in this lies in the adoption of a single-screw installation, for the vast majority of motorships built and on order are twin-screw vessels. The reasons that have led the builders to this decision are that the type of engine which they are constructing is essentially suitable for large powers, and moreover, owing to the fact that it is of the opposed piston type, it runs at a lower speed of revolution than the ordinary design. They have therefore standardized a 3,000 indicated horsepower four-cylinder set which runs at 77 revolutions per minute, and this is eminently suitable for installation in the average type of cargo vessel of 11 or 12 knots, where a low propeller speed is desirable for high efficiency. One point about this arrangement is that when steamship owners come to the conclusion, as they inevitably will, that the steam engine is too expensive to operate, they will be able to take out the whole of the steam plant and replace it by one of these Doxford engines without removing the stern gear or propeller. The advantage of this opposed-piston type for high powers can be gaged from the fact that 3,000 indicated horsepower are developed in the four-cylinder engines with the cylinders only 22¾ inches in diameter. A six-cylinder, four-cycle engine with cylinders 29 inches in diameter has an output of only 2,250 indicated horsepower, so that the possibilities of the opposed-piston type for large powers are clearly far greater than those of the four-cycle design.

There are in addition several very novel features in the Doxford engine. Solid injection is utilized by means of a mechanical pump working at a pressure of 6,000 or 7,000 pounds per square inch, while in the second place the compression pressure is very much below that which is usually considered desirable for a Diesel motor. It is in the neighborhood of 300 pounds per square inch, instead of about 480 pounds per square inch, thus allowing lighter scantlings than would otherwise be necessary. In order to achieve this, however, the tops of the pistons are maintained at a high temperature, the principle thus corresponding in a certain degree to the maintenance of a high temperature in the hot bulb of the cylinders of a hot bulb engine. When starting up, the engine has to be

warmed by passing hot water through the jackets, but otherwise there appears to be no great disadvantage in the system to counterbalance the obvious advantages which will be achieved.

A point in connection with these valveless two-cycle engines is that they can undoubtedly operate on a poorer grade of oil fuel with less detriment than the four-cycle type with its exhaust valves. This may be a point of considerable importance in the future, since fuel oil is not improving in quality, and a ship which can operate on the least pure grade will thus be a distinct advantage.

The Economy of Motorships

The economies which are now being effected by European motorships are so large that at first sight it appears they might be exaggerated. This is, however, not the case, and one or two examples of actual vessels in commission will prove what astounding results are being achieved. One instance may be given of a motorship of 6,500-tons deadweight carrying capacity which has been on the Scandinavian and North and South American run for seven years. She is a vessel of 11 knots and has a fuel consumption of 7 tons of oil per day, and owing to contracts being still in existence which were made before the war the actual cost of fuel to the owners is less than $48.70 (£10) per day. A similar steamer burns 33 tons of coal which costs $24.35 (£5) per ton, giving a total of $803.55 (£165) per day, or a saving in favor of the motorship of $754.85 (£155) each 24 hours the vessel is actually in commission.

Another case that may be mentioned is in connection with two vessels of exactly the similar size owned by the Atlantic Transport Company trading between England and the United States. These vessels carry about 6,500 tons (the motorship carrying about 350 tons extra on the same dimensions); and while the fuel consumption of the motorship is 11 tons, that of the steamer is 40 tons per day, the respective costs of fuel being $267.85 (£55) and $974 (£200), which represents an economy for the motorship of $706.15 (£145) daily.

A third instance lies with two 10,000-ton eleven-knot vessels on the Eastern run between Great Britain and India, one a motorship and the other a steamer. The former burns 10 tons of oil at a cost of $194.80 (£40) per day, while the latter consumes 36 tons of coal at a cost of $1,051.92 (£216), the saving in this case being $857.12 (£176) daily.

These figures represent actual facts and are typical of the savings which are being made in motorships at the present time; and there is a further point which is of extreme importance, namely, that whereas the steamer invariably consumes more fuel the longer it is in service, it is found that at the end of seven or eight years' commission the engines of a motorship burn exactly the same quantity of oil as the day the trial trip was run.

The Question of Reliability

Shipowners will agree that this economy is highly satisfactory, but it would be entirely nullified unless it can be shown that the motorship compares favorably in reliability to the steamer and that the cost of upkeep of the machinery is not very much higher than that of a vessel in which steam engines or steam turbines are installed. It is true that cases may be cited where considerable troubles have been experienced, and in fact in one or two ships it must be admitted that the oil-engine machinery has been replaced by steam power. Actually there have probably been not more than two or, at the most, three conversions on a large scale, and wherever it has been carried out it is due to the fact that the oil engines installed were of an experimental type upon which insufficient experience had been gained in the workshops before the motors were actually fitted in a ship. It applies almost wholly to two-cycle engines, which in the early days of Diesel engine construction gave considerable trouble, owing to an incorrect design being adopted. Such engines are no longer being built (for the most part they were valve-scavenging engines instead of the port-scavenging type which is now universally adopted), and in the modern designs all the possibilities of breakdown which were then presented have been overcome.

Leaving aside these few instances of unsatisfactory operation, the large number of motorships that have been put in service from the beginning of 1912 onwards have proved remarkably reliable. It is difficult to give facts proving the degree of reliability which has been attained, since owners of motorships are apparently none too anxious for the rest of the world to know how economical these vessels have proved to be. An instance, however, may be quoted of a Scandinavian motorship, the *Pedro Christophersen,* which has now been in commission for the past seven years, and which for the past two years has never had a shore engineer on the ship to carry out any work of repair. For the past twelve months of operation the repair bill, including all replacements and spare parts, has not exceeded $1,461 (£300), which is, of course, far lower than the average steamer of the same size, bearing in mind the attention which has to be paid to boilers on these vessels. No overhaul has been carried out for over two years and even the cylinder covers have not been removed for more than twelve months.

Again, the motorship *Selandia,* the first large internal combustion engined vessel to be put on the sea, has now been in regular commission for the past eight years, and during that time has had no serious breakdown of any sort. She has run altogether about 400,000 miles and many of her trips have been from 30 to 40 days on end with a non-stop run. Moreover, the fleet of motor-cargo vessels for the Glen Line, which are now engaged upon the runs between Great Britain and the East, are making their trips with the complete regularity of the old-time tramp. Quoting from a letter the writer recently received from an engineer on one of the largest of these ships, "they run with such absolute regularity that there is no comment to be made at all upon the engines." The repair bill on this fleet is, according to the information in the possession of the writer, rather lower than that for corresponding steamers, and out of the seven or eight ships which are now in daily service, no reports have been received of any breakdown at sea or any serious trouble ever being experienced since the first vessel was put into service.

Perhaps the most conclusive proof of the reliability of motorships, however, lies in the fact that each of the shipowners who have gained experience with motorships when placing repeat orders invariably contract for vessels fitted with Diesel motors. This applies almost without exception to every motorship-owning firm, and, in confirmation, names of such well-known concerns as the East Asiatic Company, the Glen Line (controlled by Lord Pirrie), the North Star (Johnson) Line and the Anglo Saxon Petroleum Company may be quoted, who between them own from 40 to 50 motorships, and have now an equal number on order, in each case, practically to the entire exclusion of steamers. It is perfectly clear that had motorships proved in any way unreliable, or had the cost of upkeep of the machinery been excessive, this obvious proof of the confidence now felt in the internal combustion engined vessel would not have been given.

The New Cammellaird-Fullagar Opposed Piston Type of Marine Oil Engine

BY OUR SPECIAL LONDON CORRESPONDENT

The new marine oil engine which has just been brought out by Messrs. Cammell Laird and Company, Ltd., the well-known shipbuilders of Birkenhead, is probably the most novel type that has yet been developed. The chief advantages which are claimed for this motor are that its weight, and therefore its cost, for a given power is lower than with any existing type, while the space occupied is smaller. Futhermore, it is of a design which is essentially capable of being manufactured in very high powers.

IF the claims for the Cammellaird-Fullagar opposed piston type of engine are substantiated, it is clear that the new engine must find a very wide field of application, and the builders have already engaged upon a policy of manufacture of standard engines of 1000-horsepower for installation in single or twin screw cargo ships. It is hoped in the near future to build motors of this type up to 4,000 brake horsepower, and still larger sets are already contemplated.

The principle of operation can be seen from the drawings, Fig. 2 and 3. The reproduction from a photograph represents the first mercantile engine, which is a motor of four cylinders, 14 inches in diameter with a total stroke of 40 inches developing 500 brake horsepower at 120 rev-

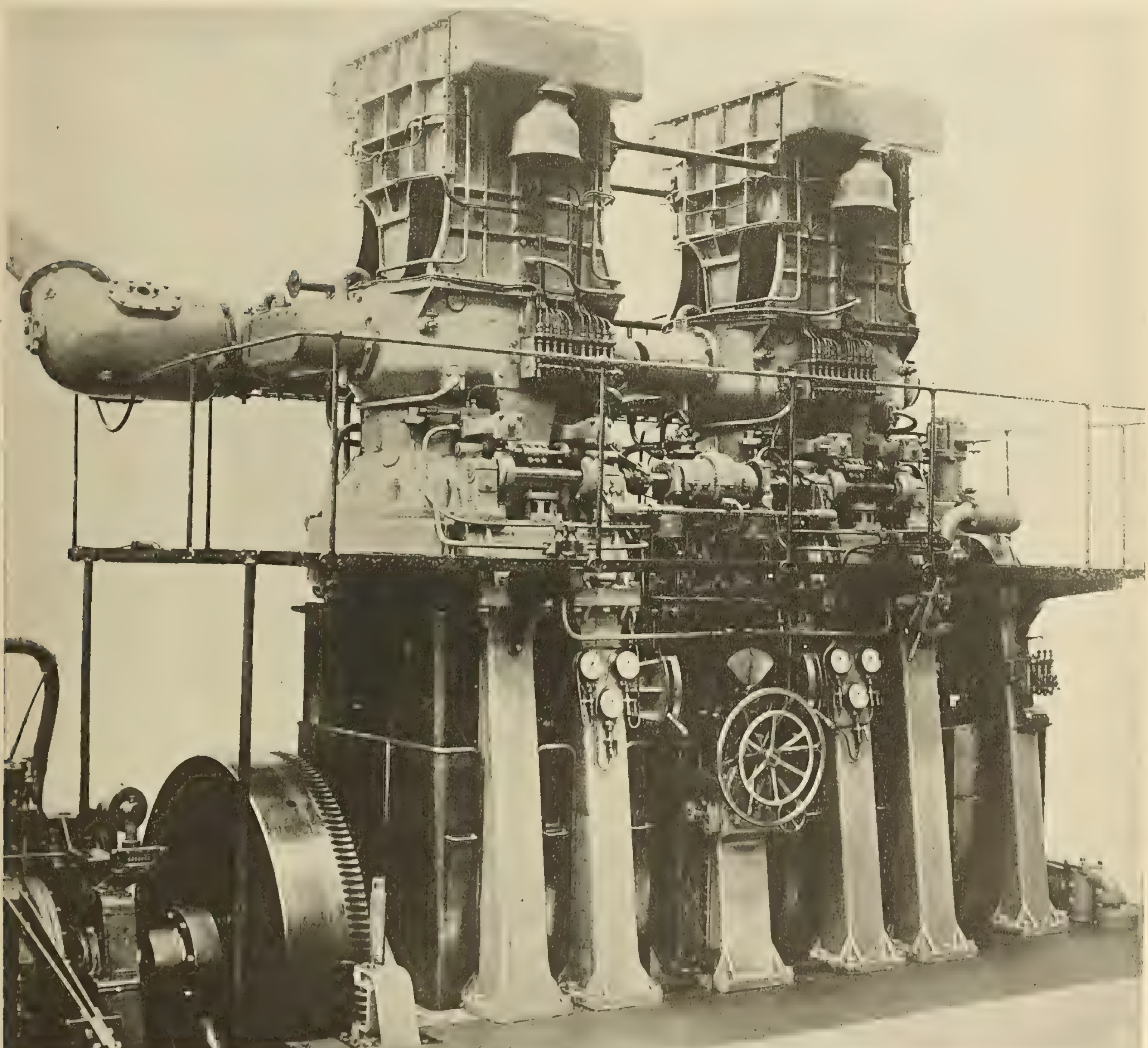


Fig. 1.—500-Horsepower Cammellaird-Fullagar Marine Oil Engine for Installation in an Electrically Welded Ship

olutions per minute. This motor is to be installed in an electrically welded coasting vessel which is approaching completion in the yard of the builders of the engine.

Each unit consists of two cylinders, with a common water jacket, in which are carried two separate liners which form the cylinders, these being open both at the top and bottom. In each cylinder are two opposed pistons, moving inwards and outwards together. The cranks of two adjacent cylinders are set at 180 degrees, so that when the pistons of one cylinder are at their nearest point of approach those of the next cylinder are furthest apart. The crossheads of the top pistons are joined by means of two diagonal rods to the crossheads of the bottom adjacent pistons, so that there is a resulting cushioning effect, which reduces the load on the bearings and enables a lighter framing to be employed than with ordinary motors. Each unit of two cylinders is carried upon two cast-iron columns, which on the inner side form the crosshead guides. There is no bearing between two adjacent cranks, so that the length of the engine is relatively small; and as the motor is of the open type, all parts are readily accessible.

Injection of Fuel

In other respects the Cammellaird-Fullagar engine, as it is called, follows much along the lines of the ordinary opposed piston design. The fuel is injected by means of

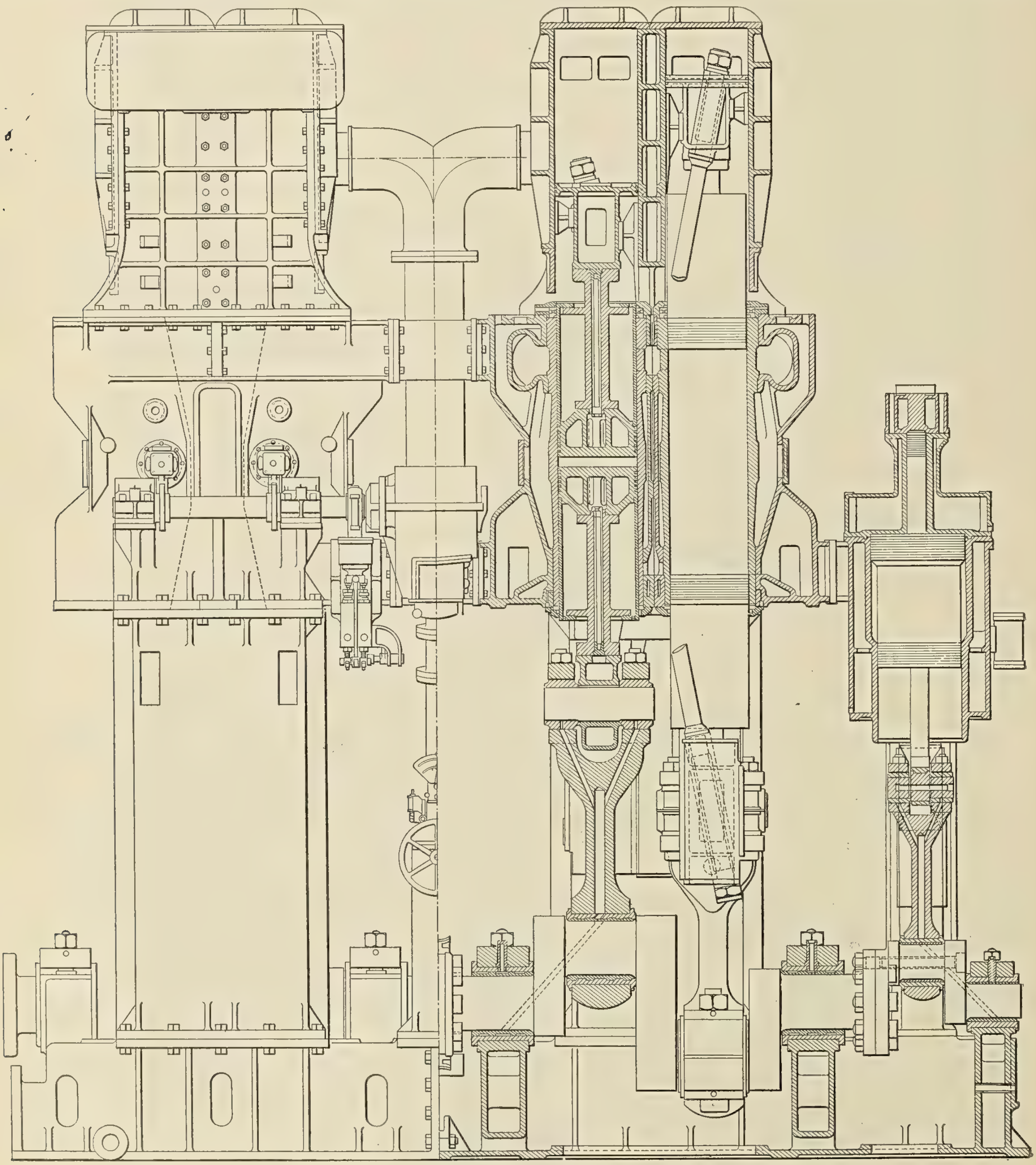


Fig. 2.—Side Elevation and Partial Section of Cammellaird-Fullagar Engine

a centrally placed fuel valve, just before the pistons reach their nearest central point, the combustion chamber being thus formed between the tops of the two pistons. Right at the bottom of the cylinder are arranged ports all around the circumference through which scavenging air is admitted when these ports are uncovered by the bottom piston in the course of its stroke. Exhaust takes place through a similar series of ports right at the top of the cylinder, these being uncovered in their turn by the upper piston just before the end of its stroke. The scavenging air thus passes right through the whole cylinder and a very good scavenging effect is obtained, giving the engine a high efficiency for a two-cycle type, the fuel consumption being 0.42 pound per brake horsepower hour.

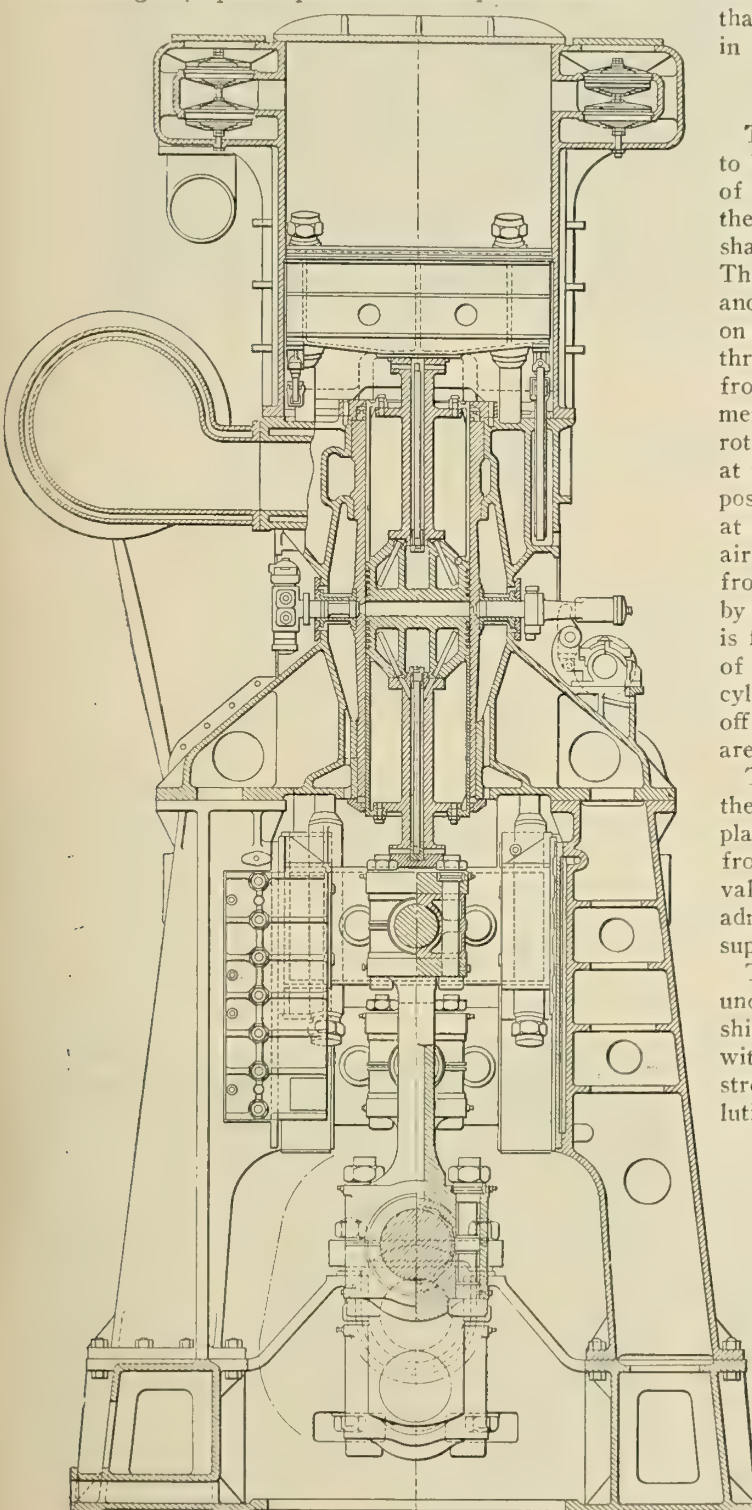


Fig. 3.—Cross Section Through Cylinder

The scavenging pumps are very simply designed by boxing in each top crosshead, which thus forms the piston of its scavenging pump. In this way, floor space is saved, while there is practically no increase in the height of the engine beyond what would be necessary were the scavenging pumps arranged either at the forward or after end of the engine. The air supply both for the injection of the fuel and for starting purposes is obtained from a three-stage vertical air compressor driven from a crank off an extension of the crankshaft at the forward end, while the two pumps for the circulating water and lubricating oil are also fixed at this end of the engine, driven from eccentrics and being of the plunger type. The lubricating oil is also used for cooling the pistons, which is a system that has been frequently adopted for Diesel engines, but in large sets fresh water would be utilized.

Valve Gear

The fact that only the fuel and air-starting valves have to be accommodated leads to a considerable simplification of the gear. The camshaft, which can be seen just above the top of the engine framing, is driven from the crankshaft by means of bevel gearing and a vertical shaft. There is only one horizontal fuel valve for each cylinder, and this is actuated by means of short levers from cams on the camshaft. When reversing, this camshaft is turned through a small angle by rotating the reversing wheel in front of the engine which lifts the vertical driving shaft mentioned above, thus causing the camshaft to be partially rotated. The cams are thus set relative to the crankshaft at the right timing to open the fuel valves in the correct position for astern running. The starting air valves are at the same time set in a position to admit compressed air to the right cylinder when the starting wheel on the front of the engine close to the reversing wheel is turned by the operator. By this movement the compressed air is first supplied to all four cylinders. A further rotation of the starting wheel cuts off the air supply from two cylinders, and admits fuel, while the final movement shuts off all the air and admits fuel to the four cylinders which are then operating under normal conditions.

The speed of the engine when running is controlled by the hand throttle on the right-hand side of the starting platform, this causing more or less fuel to be by-passed from the delivery side of the fuel pump to the suction valve. There is another hand lever which controls the admission of injection air so as to reduce the quantity supplied when the engine is running at low speed.

Two further engines of 1,000 brake horsepower are now under construction for installation in a 6,000-ton motorship. These comprise two units of two cylinders each with cylinder diameters of 18½ inches, and a total piston stroke of 50 inches. The power is developed at 110 revolutions per minute.

Globe Repair Yard to Have Crandall Dry Dock

The Globe Shipbuilding & Dry Dock Company, Baltimore, Md., is to have at its new repair plant a 9,000-ton floating drydock of the latest design. This dock is of the longitudinally-trussed sectional type, designed and developed by The Crandall Engineering Company, drydock engineers, Boston, Mass. It measures 440 feet over the keel-blocks and 83 feet between the wing walls. The pumping is accomplished by 24 electrically operated centrifugal pumps, the control of which is so centralized with indicators that the dockmaster may readily govern the pumping in all the compartments of the dock.

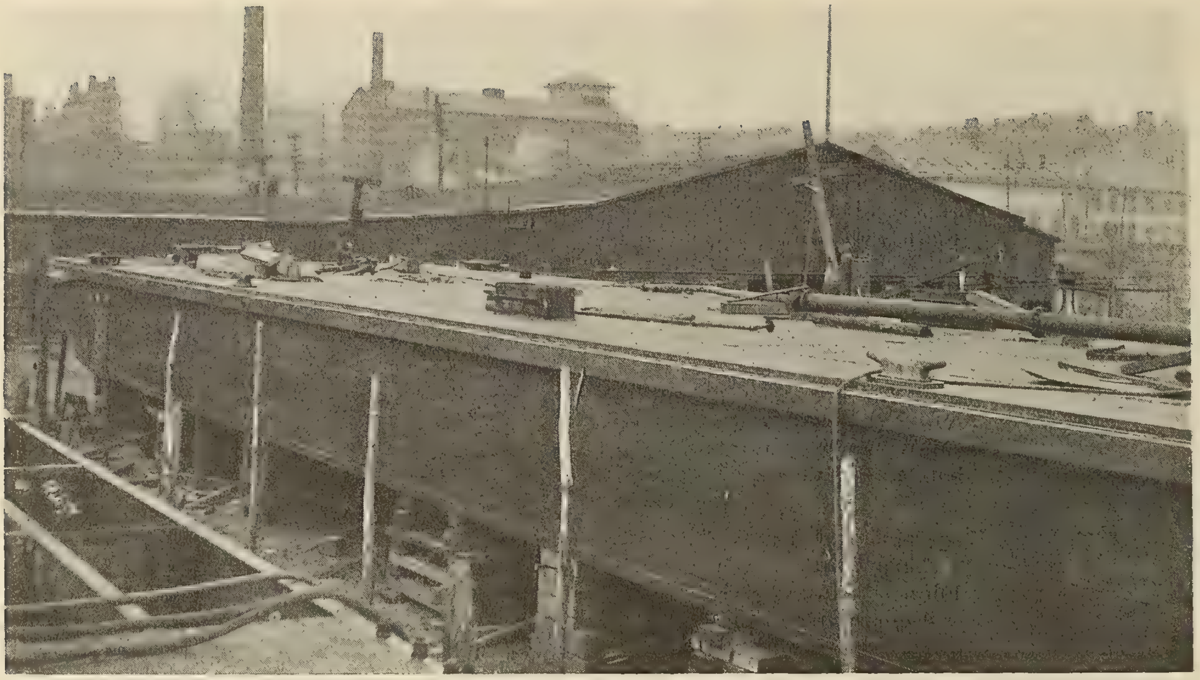


Fig. 1.—Riveted Barge Ready for Launching. The Same Ways Were Afterwards Used for Construction of Welded Barge of Same Type

Electrically Welded Ships

BY WILLIAM T. BONNER*

That shipbuilders and shipowners do not take welding more seriously is deplored by the author, since to both must come great gains not alone in prestige and efficiency of service but also in remuneration. Many examples of the saving of time and materials required for the fabrication of ship's parts are cited in this article as proof of the claim that electrically-welded jointures are stronger, more efficient, and yet cheaper than riveted work. From what has actually been accomplished, it is perhaps not unreasonable to expect that ere long ship welding will come into its own.

THE earliest undertaking of record wherein electric welding was exclusively employed in the fabrication of important strength members of sea-going vessels was that carried out by the writer at Newburgh, N. Y., on the Hudson River, in April, 1917. The vessel was a 1,200-ton bulk oil barge designed for service in Mexico. Her dimensions were: Length, between perpendiculars, 165 feet 3 inches; breadth, molded, 37 feet 9 inches; depth, 8 feet 6½ inches. The shell and deck plating was of ¼-inch, while the transverse framing members, intercostals and the like, were all of 5/16-inch plating. As may be noted by reference to Figs. 4 and 5, the arrange-

* Engineer, welded ship construction; member Society of Naval Architects and Marine Engineers; American Bureau of Welding and American Welding Society.

Fig. 2.—Keel Plates for Welded Barge. Note Badly Buckled Condition of Plate Edges. Latter Were All Drawn Up Perfectly Straight for Welding Without Use of Bolting Holes

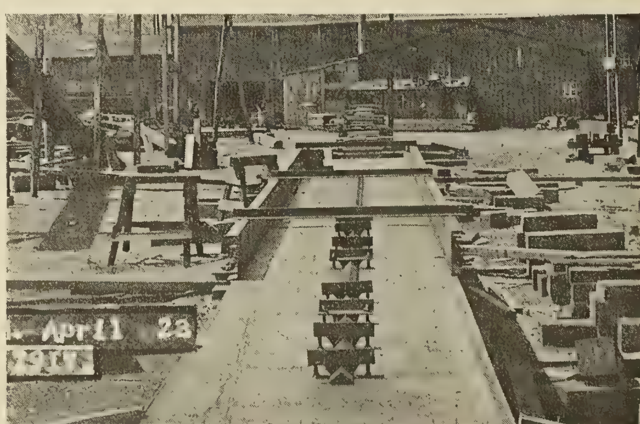


Fig. 3.—Keel Plating with First Longitudinals and Bottom Support for Centerline Bulkhead "Tacked" in Place. Note How Plate Edges Have Been Straightened.

Fig. 4.—Finished Connection Between Centerline Bulkhead and Underside of Deck Plating with Inboard Section of Transverse Frame

Fig. 5.—Looking Aft Along Port Side of Centerline Bulkhead, Showing Longitudinal Bulkhead Stiffeners and Bottom Longitudinals with Inboard Portion of Transverse Frames

ment of longitudinal and transverse framing followed the Isherwood design, while, generally, the selection of materials and details of construction were carried out in accordance with Lloyd's specifications.

After completing the principal midship section by welding, the remaining portion of the barge was constructed by riveting in order to compare construction and maintenance costs of the two types. The welded section extended from the watertight midship bulkhead to the forward transverse bulkhead, also watertight, and included the keel plates with adjoining longitudinal bottom strakes, and the entire superimposed centerline bulkhead structure with inboard portions of the intermediate transverse frames. Thus it will be seen that the section of the barge selected for welding included a considerable portion of the most important strength members, and the results

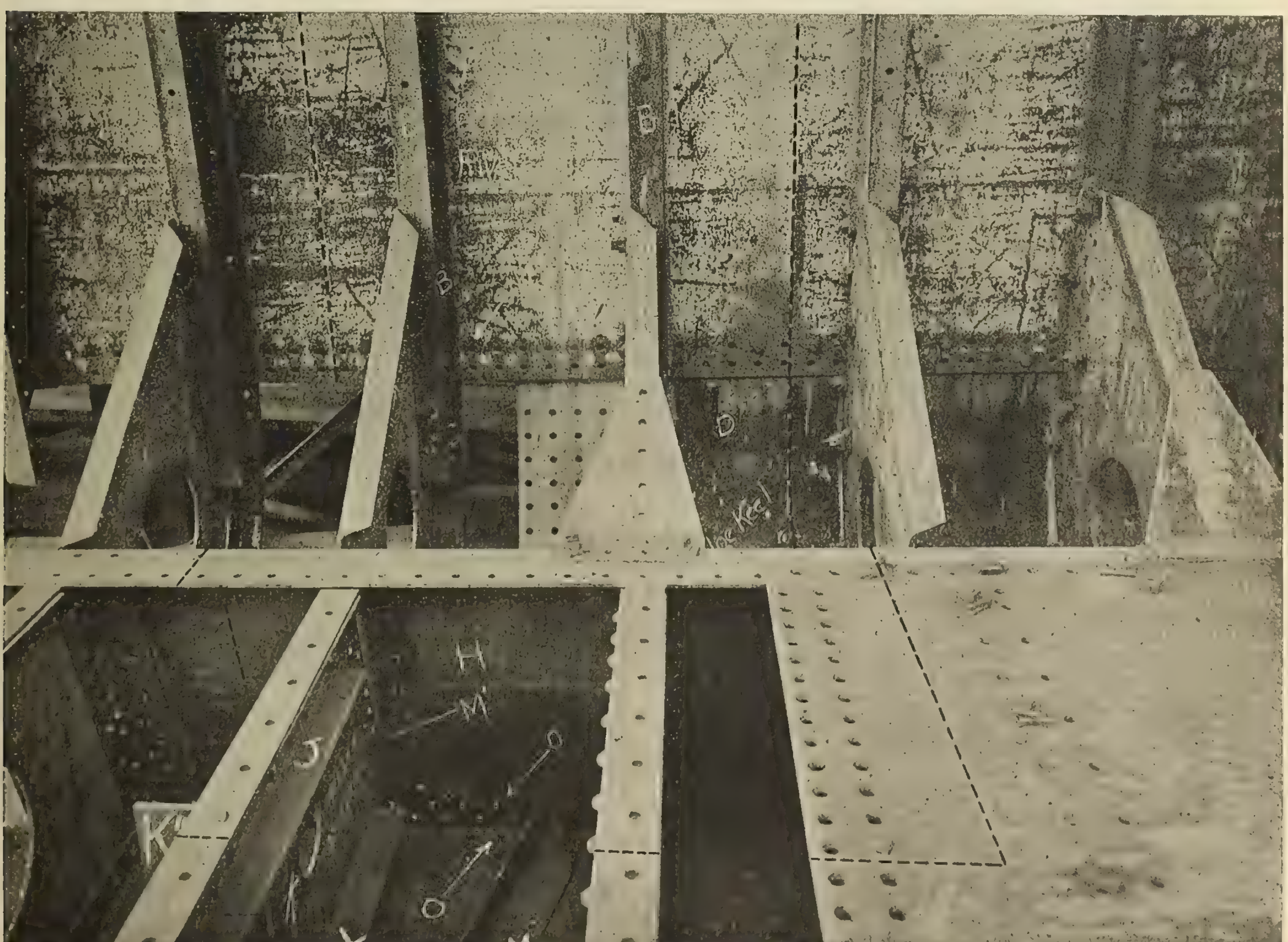


Fig. 6.—Portion of Bilge of 10,500-Ton Cargo Ship Defined by Dotted Lines Shown for Comparison with Welded Section of Same Size and Shape Shown in Fig. 8

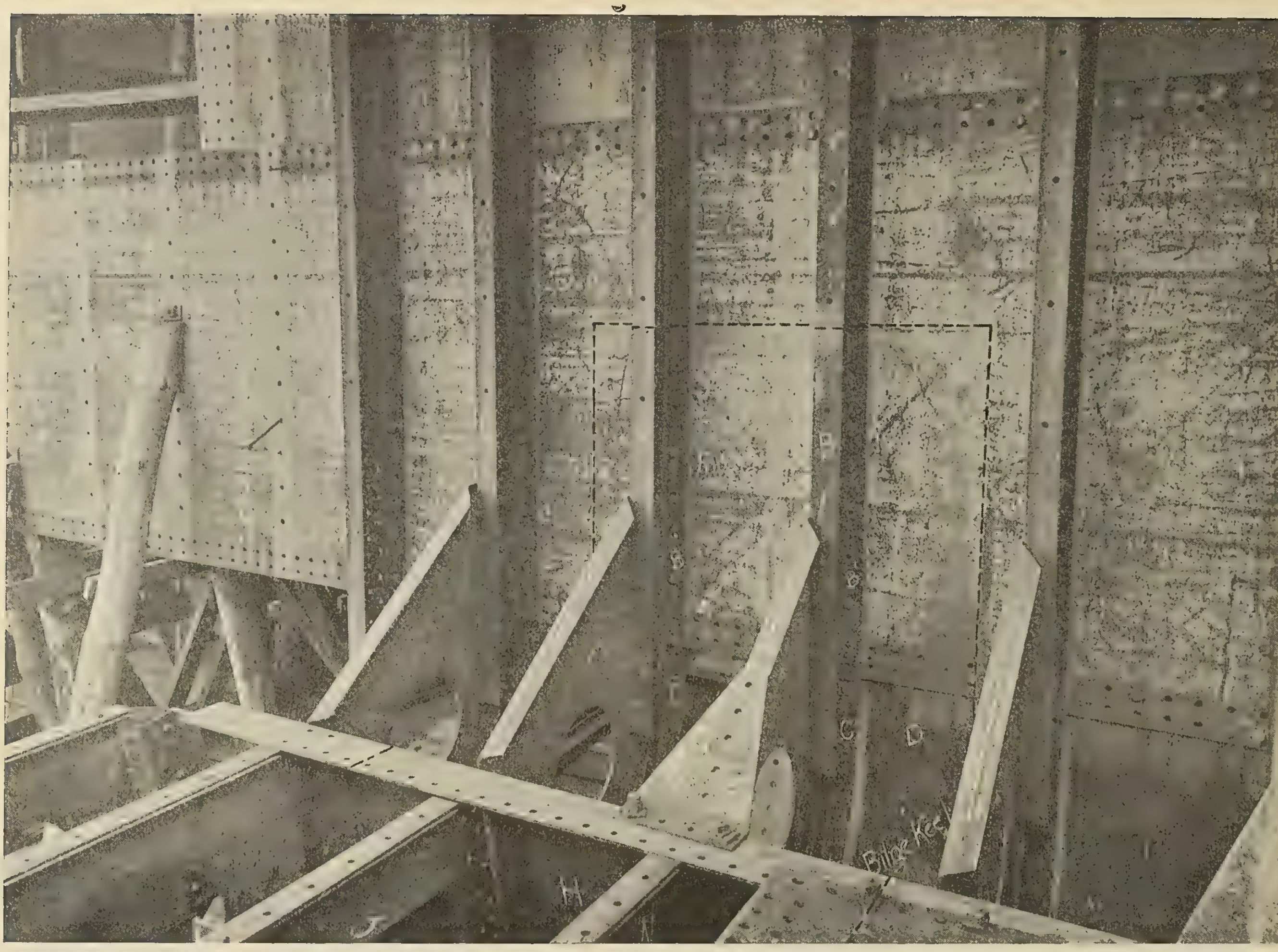


Fig. 7.—Bilge Section of Standard Riveted Cargo Ship. See Fig. 8 for Duplicate of This Section, Reproduced as an All-Welded Structure

attained may be taken as indicative of what may be expected of a vessel wholly fabricated by welding.

Because of the badly twisted and buckled condition of the plating and framing supplied for the job, the work of assembling was considerably handicapped. Some idea of this may be obtained from the photograph (Fig. 2) of the keel plates as laid on April 19, 1917. The other view of the keel plating and longitudinals (Fig. 3) as of April 22, 1917, shows how completely the buckled condition was eliminated, and by reference to the port side views of the finished centerline bulkhead (Figs. 4 and 5) it will be noted that all framing and plating was brought up perfectly true and square.

Incidentally, it may be stated also that this condition was quickly and easily attained without punching or drilling a single hole in either plating or framing.

From the above and various contemporary welding operations, the writer draws the following conclusions as to the results which may be regularly attained by conscientious, intelligent operators:

First, straight work may be made out of very badly bent and twisted plates and channels.

Second, thin plates of large area may be welded without a warp or buckle.

Third, tight joints, metal solid against metal, may be obtained without punching a single hole for holding bolts.

Fourth, work may be finished absolutely square and true to chalk line or straight edge.

Fifth, feature No. 3 may be accomplished with less than one-half the expenditure of time and materials required for previous methods of assembling work.

The table of relative costs (Table I) is appended to illustrate the saving which could have been effected by electrically welding the entire barge structure. All figures

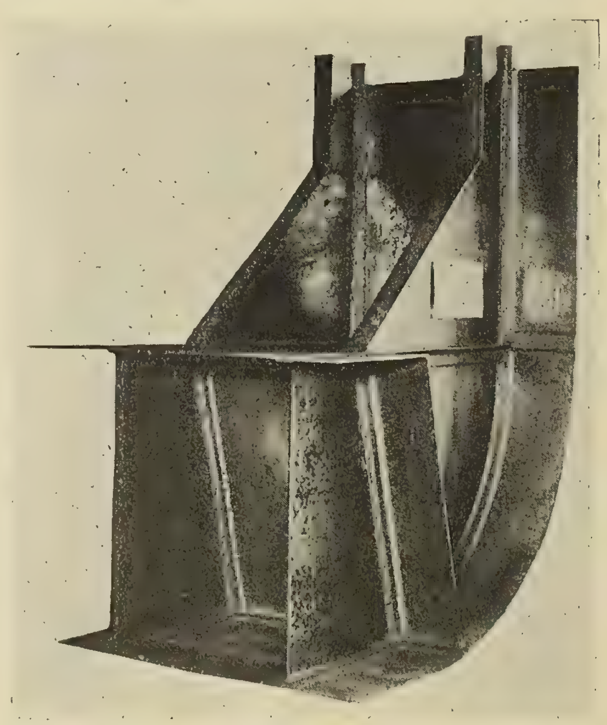


Fig. 8.—Quarter View of Bilge Section of Rivetless Cargo Ship

in the first column were pro-rated from actual book accounts of the cost of constructing three barges of similar size and type, while those in the second column were developed from the actual cost account of welded work on the 60-foot section above described.

TABLE I.—ESTIMATED CONSTRUCTION COST OF 166-FOOT BY 39-FOOT BY 8-FOOT 8-INCH BARGE.

Based on 1917 Wage Rates and Material Prices

	Items	Riveted Design **	Welded Type
A	Plate Fitters	$1,236.00	$618.00
B	Punching and Shearing	1,045.00	522.00
C	Countersinking and Reaming	976.00	0.00
D	Riveting	3,427.00	0.00
E	Chipping and Calking	523.00	265.00
F	Smithwork	557.00	275.00
G	Erection and Assembling	2,010.00	1,320.00
H	Electric Power	382.00*	95.00*
I	Foreman	360.00	360.00
J	Plant—Special Equipment	0.00	300.00
K	Superintendence	0.00	900.00
L	Rivets	780.00	0.00
M	Liners	142.00	0.00
N	Shed and Shoring Lumber	0.00	145.00
O	Electric Welding—Including "Tacking" 51,300 feet Single Fillet— Welders—6,000 hours at 60 cents $3,600 Current—6,000 x 5=30,000 K. W. H. at 2½ cents 750 Wire—7,200 lbs. at 6½ cents 450 $4,800	0.00	4,800.00
P	Incidentals and Profit	0.00	1,838.00
Q	Total	$11,438.00	$11,438.00

* Current used for lighting, punching, shearing and air compressors only. Current for welding covered in Item "O".

** All figures for riveted design based on actual book cost of three barges completed during preceding month.

TABLE II.—COMPARATIVE DETAILS OF RIVETED AND RIVETLESS SHIP STRUCTURES DEVELOPED BY MEASUREMENTS OF ACTUAL BILGE SECTIONS (ILLUSTRATED BY APPENDED PHOTOGRAPHS)

Ref.	Particulars	Riveted	Welded
A	Weight of Plates required	2488 Lbs.	1884 Lbs.
B	Weight of Angles, Beams and Channels	764 Lbs.	194 Lbs.
C	Weight of Straight Bars	none	360 Lbs.
D	No. of ⅝-inch Rivets	48	none
E	No. of ¾-inch Rivets	231	none
F	No. of ⅞-inch Rivets	108	none
G	Total Number of Rivets	387	none
H	Total Weight of Rivets	200	none
I	Number of Liners required	4	none
J	Weight of Liners	31 Lbs.	none
K	Weight of Weld Material added	none	120 Lbs.
L	Total weight of complete section	3,483 Lbs.	2,558 Lbs.
M	Lineal Feet of Heavy Flanging and Shaping	22	none
N	Square Feet of Forge Shaped Bilge Plate	24	none
O	Square Feet of Machine Rolled Bilge Plate	none	20
P	Number Lineal feet of Welds in terms of ¼ square inch section	none	620
Q	Number Lineal feet of Calked Edges	57	none
R	Total Number of all Rivet Holes in Section	826	none
S	Average Area of Plates of full size	17,280 sq. in.	15,235 sq. in.
T	Average Number of Rivet Holes in same	550	none
U	Average Area of Rivet Holes in same	431.97 in.	none
V	Reduction of Plate Area due to Punching	2½%	none
W	Typical Number of holes in Rows across Plate	15	none
X	Average Total Diameter of Rows across Plate	15%	none
Y	Average Proportion of Hole Diameter to Plate	25%	none

NOTE:—

1. Above includes no allowance for bilge keel.
2. All plates are calculated as of same thickness for both types.
3. Difference in weights given in item "A" due to butting plate edges for welding instead of using lapped seams for riveting.

When completed the barge was loaded with 500 tons of fire brick, pipe, lumber, cement, etc., and towed 60 miles to New York, where it took on about 500 tons of pumping machinery. With this near capacity cargo the barge started on an ocean voyage of 2,500 miles around the capes to Tampico, where it arrived in due course with hull and cargo in good condition.

No repairs have thus far been required, notwithstanding the fact that the barge has been in service nearly three years as a bulk oil carrier between Mexican Gulf ports and the Panuco River wells, while the rapid current, wind and tides combine to make navigation difficult.

Another practical demonstration of the superior merits of welded construction was developed by the writer at the Chester, Pa., yard of the Merchant Shipbuilding Corporation during the early part of 1918. This consisted in duplicating, in a completely welded structure, a certain section of the outboard bilge portion of a 10,500-ton cargo ship, as may be more particularly defined by noting dotted lines on Figs. 6 and 7. By reference to Fig. 8, which illustrates an exact counterpart of the section thus defined, there is afforded a striking picture of the simplicity of the typical rivetless ship.

To make this comparison even more convincing, the following table of weights and costs is appended:

Practically all who inspected this welded section united in the opinion that it afforded a positive demonstration of the advantages of electric welding in securing rigidity of structure, low frictional resistance, ample bracing, smooth interior and exterior surfaces and freedom from corrosive tendencies.

From the weights given in Table II it may also be deduced that, with the tonnage of plates and shapes required for building five riveted ships, *six ships might be constructed by the welding method.*

During the winter of 1916-17 the tug *Margaret*, owned by the Great Lakes Dredging Company, was overhauled at the company's Albany shop. The work was done under the immediate supervision of the foreman of repairs, Mr. Andrew Muir, who reported the vessel as in very bad condition. Owing to the badly corroded state all hull plates below the waterline had to be replaced, and the frames pieced out and reinforced. All of above replacement work was done by electric arc welding. The hull plates were ¼-inch steel, with lap seams fillet welded on both edges.

When the repairs were finished the *Margaret* was again put into commission, and has since continued in active service. She is now stationed at Buffalo and is reported in fine condition.

As a further illustration of the comparative merits of riveted and welded structures, shipowners and builders will find food for serious thought in the following description of foundations designed to support the fuel oil tanks in certain cargo carriers now building by one of our large shipyards. Having been added to the original contract specifications and all installation work delayed until the ships were ready for launching, the girder foundations had to be fitted to existing tank tops and bulkheads.

For convenient comparison, both riveted and welded types of foundations are shown more or less in detail in Plates 1-7. Plate 1 reproduces the principal details of design for riveted type girders, while Plates 2 to 7, inclusive, have been prepared to show the assembly and details of a welded structure.

For convenience, the plan view of the welded girder arrangement is made to show only the port side half of foundations in hold No. 4, and the same is true of the succeeding plans and elevations shown on Plates 3 to 7, inclusive. Unless otherwise specified, therefore, it must be understood that all drawings, weights and prices are given as and for a one-fourth portion of the complete installation required for the two holds, 4 and 5.

In the design for welded tank foundations (see Plates 2, 3, 4, 5, 6 and 7) it will be noted that all longitudinal girders are shown intercostal between watertight bulkheads 74 and 90, as also between 90 and 106, except Nos. 5 and 6, port and starboard, in the way of the watertight

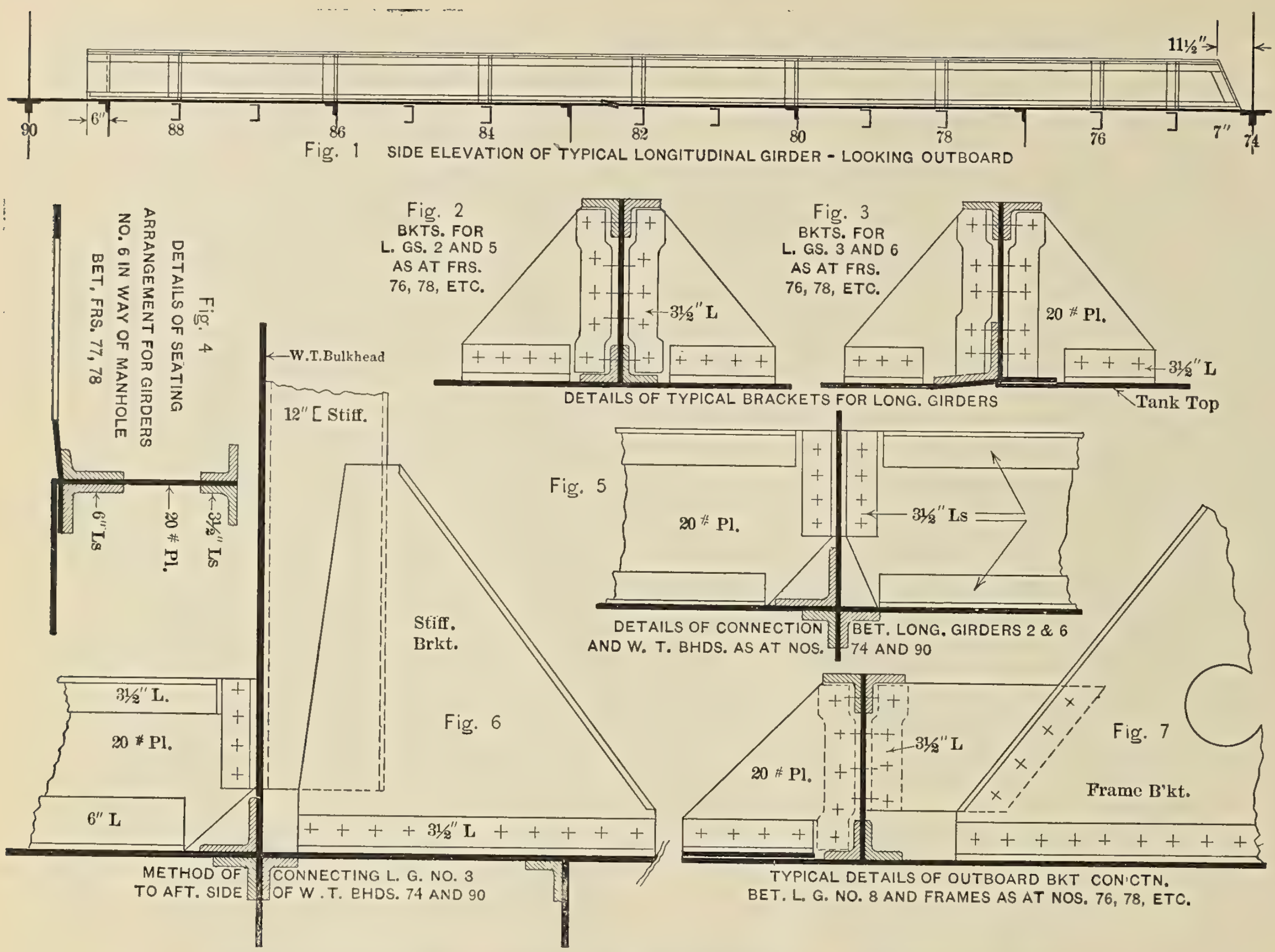


Plate 1.—Essential Details of Riveted Oil Tank Foundations for 12,000-Ton Cargo Ships

bulkhead stiffener brackets, to which they are rigidly attached as by butt welds.

Each welded girder consists of a superimposed T-section (see Plate 5) with the bottom edge of the web member butt welded to the top edge of a series of plates of trapezoidal shape. This augmented section is further combined with the tank top plating by "butt to top surface" welds over each floor, thereby forming a plate girder of great rigidity and strength.

There is provided also a series of transverse girders (see Plates 2 and 3) disposed as intercostals between the several rows of longitudinal girders, the whole being welded to each other and to the tank top as a homogeneous unit structure extending over the entire fore and aft length of holds 4 and 5 and to and between the port and starboard frames.

As a final addition to the rigidity and strength of foundations, there is provided at each midway point between the intercostal girder connections to longitudinals a pair of brackets which are fitted to the girder and tank top and "butt to side" welded, as shown in half section on Plate 5. Fig. 7 on Plate 4 (compare Fig. 7 on Plate 1) illustrates the base connection between the outboard longitudinals (girder 8) and the ship's framing, in line with each transverse girder.

In point of time is is possible to complete such structures much more quickly than by riveting, provided a sufficient number of welders are employed. Approximately five welders and machines would be engaged for 26 working days of 8 hours each to complete the one-quarter unit shown in the sketches; but if 40 or more welders were employed, the entire foundations for holds 4 and 5 could be finished in 13 days or less.

Moreover, it must be patent to all that the material could be prepared for installation very quickly, because of the fabricating operations being limited to shearing the plates for girders and brackets. Of these there would be required a total of 225 plates, all but one of which are 11 inches wide, of short lengths and similar shapes (see template sheets Nos. 6 and 7).

It is a generally recognized fact that for each department dealing with the fabrication of an article, no matter how small a part it may have in the production of that article, allowance must be made for the overhead cost of routing the job and supervising its passage through said department. Obviously, the fewer the operations required for the fabrication of an article, and, per se, the fewer departments there are contributing to its production, the less it will cost in time, transportation and overhead.

From records of similar undertakings, information developed in the construction of foundations for ships now building, and by estimating the costs of labor and material required as indicated in the drawings, it is expected that the two types of foundations will closely approximate the unit totals tabulated in the schedule of comparative costs (see Table III). In this table the figures for riveted type foundations were developed by the shipyard's estimating department.

In justice to the claims of welded construction, and by way of protesting the customary method of estimating costs by adding some predetermined percentage for overhead, it is contended that the respective amounts, $150

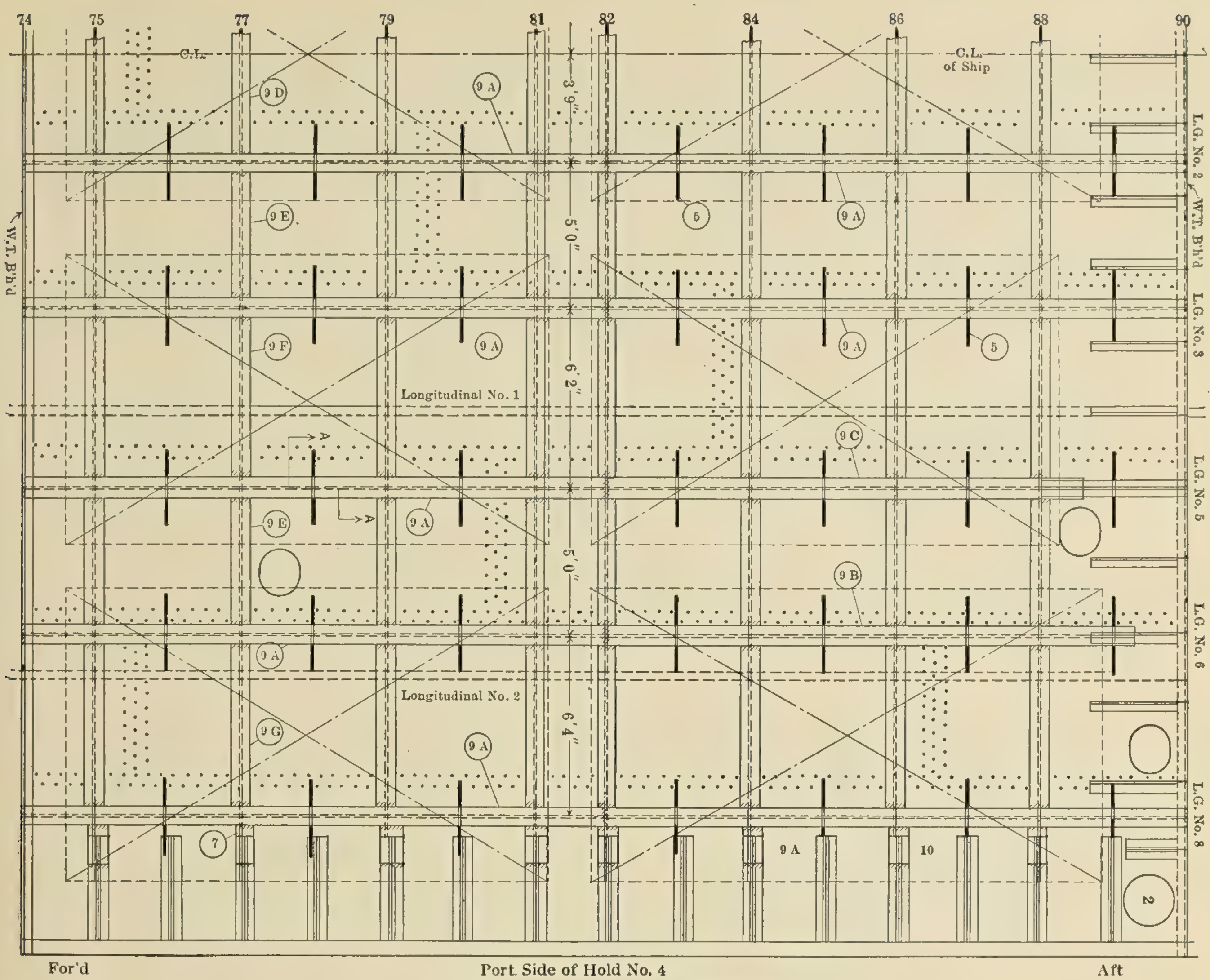


Plate 2.—Plan of Welded Foundations

and $50, for supervision and power required in connection with the riveted type foundations, (see items 19 and 20) are pure guesswork. As a matter of fact, the results thus far reported on these jobs indicate that both will greatly exceed the figures used.

One of the very attractive features of welded construction is its freedom from uncertainty in the matter of costs. Not alone does it permit the absolute elimination of numerous fabricating operations, but the exceeding simplicity of the welding method and the certain fixed relation which its power, material and labor input bears to the fabricated product, enable the estimator to provide advance cost schedules which may be depended upon as closely appromixating 100 percent correct. With the sure approach of keen competition in ship construction, the successful yard must discontinue the present practice of "lumping" the cost of all operations of uncertain analysis into the "overhead" account. There is no question as to the unfairness of handicapping what might otherwise be a very profitable undertaking by adding an abnormal overhead simply because it happens to be carried out in the same yard with other jobs of similar character but loaded with numerous costly operations and expensive supervision.

While admitting the undoubted strength of riveted girder foundations to meet the stress of ordinary heavy seas, it is believed the surging content of one or more partly filled tanks rigidly attached to such girders will some day destroy the oil-tightness of the inner bottom. By calculation there are over 5,600 rivets driven through the tank top for securing the girders in the two holds, hence the possibility of trouble from this source is just 5,600 times that due to damage to electrically welded foundations, since the latter do not require a single perforation in the tank top.

By reference to Fig. 2 on Plate 5 it will be noted that the base section at the point of contact between the girder and tank top is in the form of a +, the spread of which is sufficient to provide great structural rigidity and yet the metal is thin enough to permit cutting away the entire foundation structure and chipping off any roughness remaining on the tank top when the oil tanks must give way for enlargement of cargo space.

In view of such possibility it would be a matter of very grave concern to the owners to contemplate the cost and delay incident to the removal of riveted foundations with 5,600 rivets to be cut out, 5,600 holes in the tank top to be refilled and made oil-tight, tanks retested and the ship otherwise restored to its original condition. As in the original installation, *with a welded structure there would be no perforation of the tank top, and, consequently, no necessity for retesting the inner bottom tanks.*

As a weight-supporting structure the welded foundations above described possess the advantage of ample bearings at all critical points, and the intercostal arrangement of girders insures a most efficient form of longitudinal and transverse bracing.

From an economical standpoint, welded construction

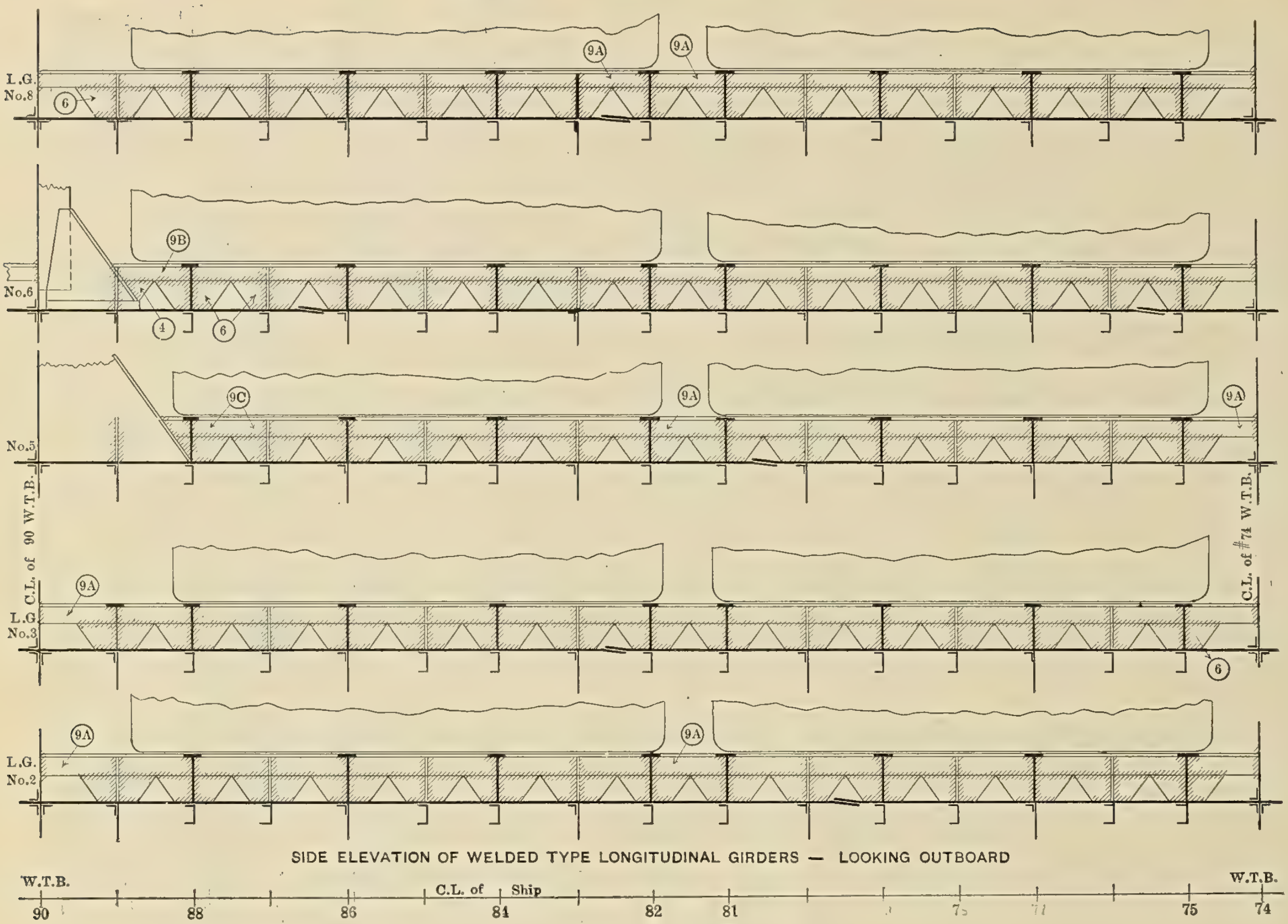


Plate 3.—Welded Type Longitudinal Girders

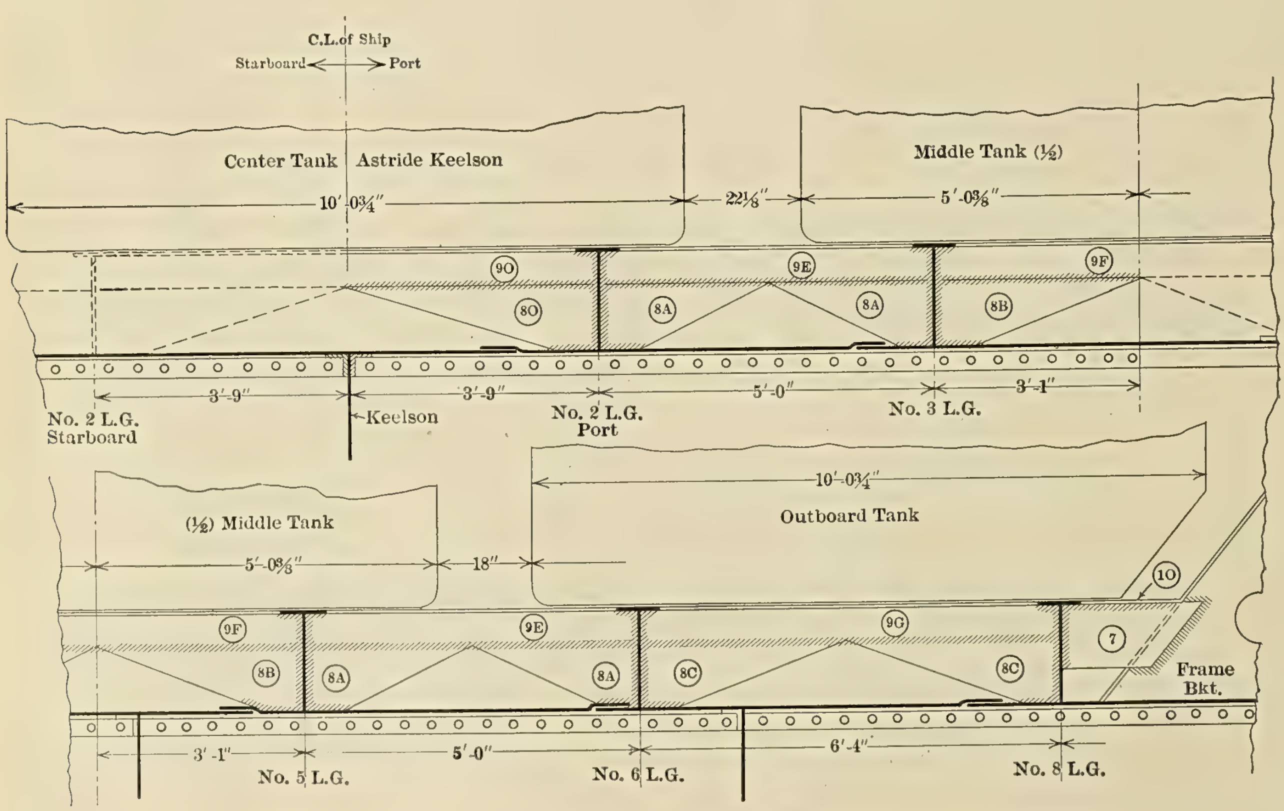


Plate 4.—Elevation of Typical Intercostal Girder, as on Floor No. 77, Hold No. 4, Looking Aft

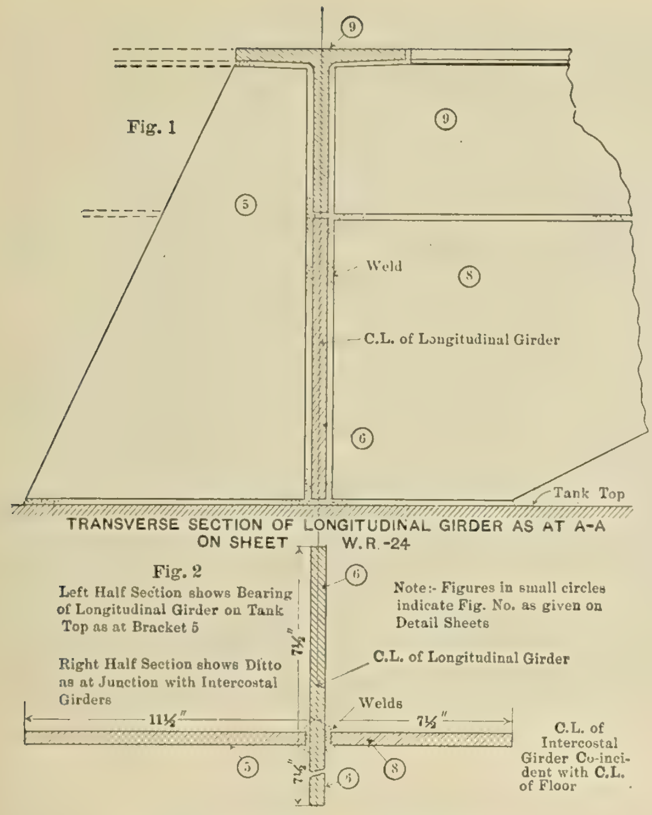


Plate 5.—Sections of Longitudinal Girder

has the advantage of permitting the utilization of scrap material in many places. By enlargement of the weld section any joint may be made to exceed the virgin plate in strength, hence "piecing" may be followed to the complete elimination of the scrap pile except where objection is made to the appearance of seams.

As a matter of interest to the shipowner, the saving in weight of structure, with no diminution of strength or safety, means lower initial costs, and, most important of all, greater operating returns. Since each pound reduction in weight of ship permits carrying another pound of cargo, the weight reduction obtainable by adopting welded foundations for oil tanks would permit loading *more than 10 tons additional cargo each voyage* without affecting the speed or sailing cost. And, what is true of the constructive and operating features, hereinabove mentioned, is likewise applicable to practically every detail of the ship's structure.

Examples of Welded Ships

That the reader's interest may be satisfied by a near complete record of the more important undertakings in the line of electrically welded vessel construction, reference will now be made to one other American boat and to those built in foreign countries which have received official sanction and more or less attention by the technical press.

It should not, however, be understood that the examples referred to represent the full extent to which electric welding is now employed in ship construction. As an indication of the more extended application of welding to the fabrication of ships' parts, the reader's attention is invited to the schedules of permissible welding now authorized by the United States Navy and the classification societies, as featured elsewhere in the present issue of this journal.

A Welded Motorboat

The welded motorboat *Dorothea M. Geary* was built by the Geary Boiler Works and launched at Ashtabula, Ohio, about December 1, 1915. Her dimensions are: Length, 42 feet; beam, 11 feet; depth, molded, 6 feet 6 inches; draft, 3 feet 4 inches. Her frames are 1½-inch by 1½-

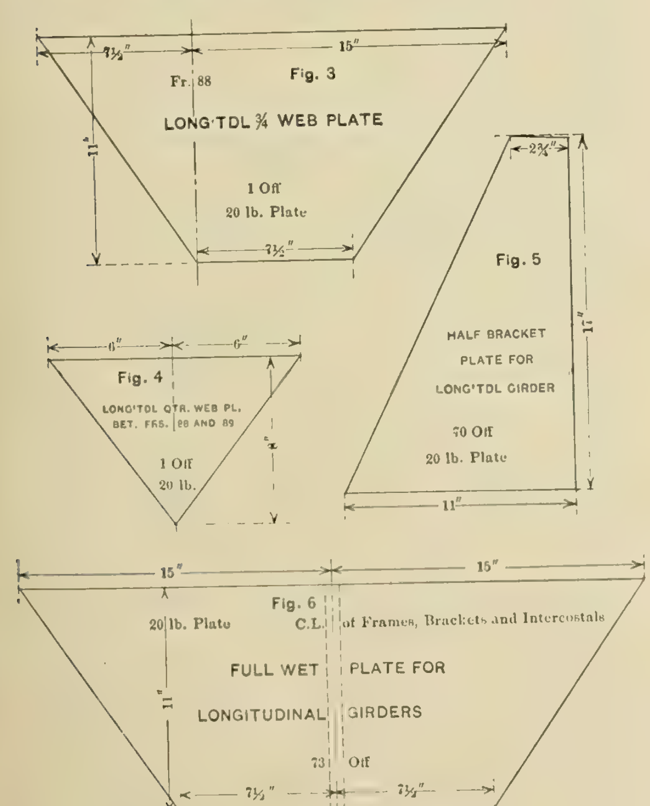


Plate 6

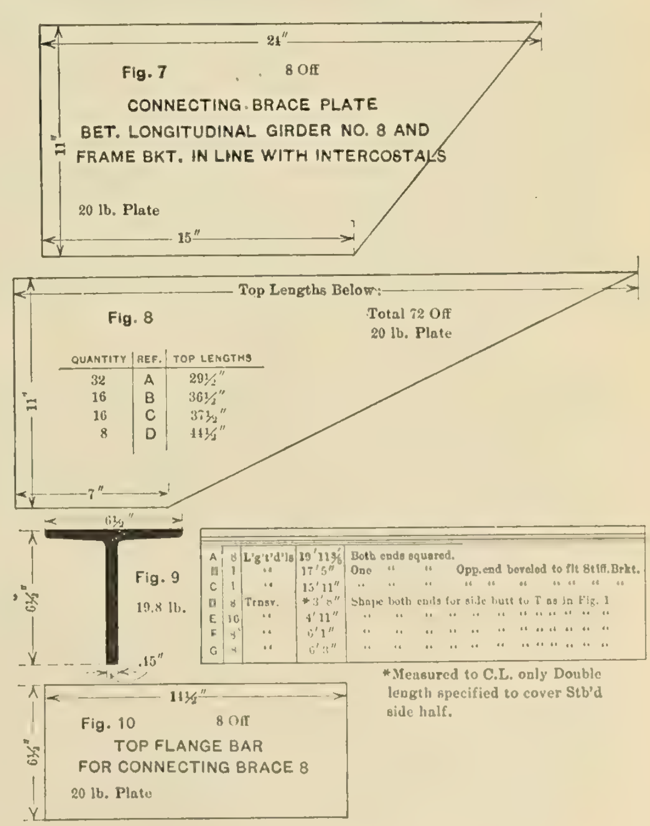


Plate 7

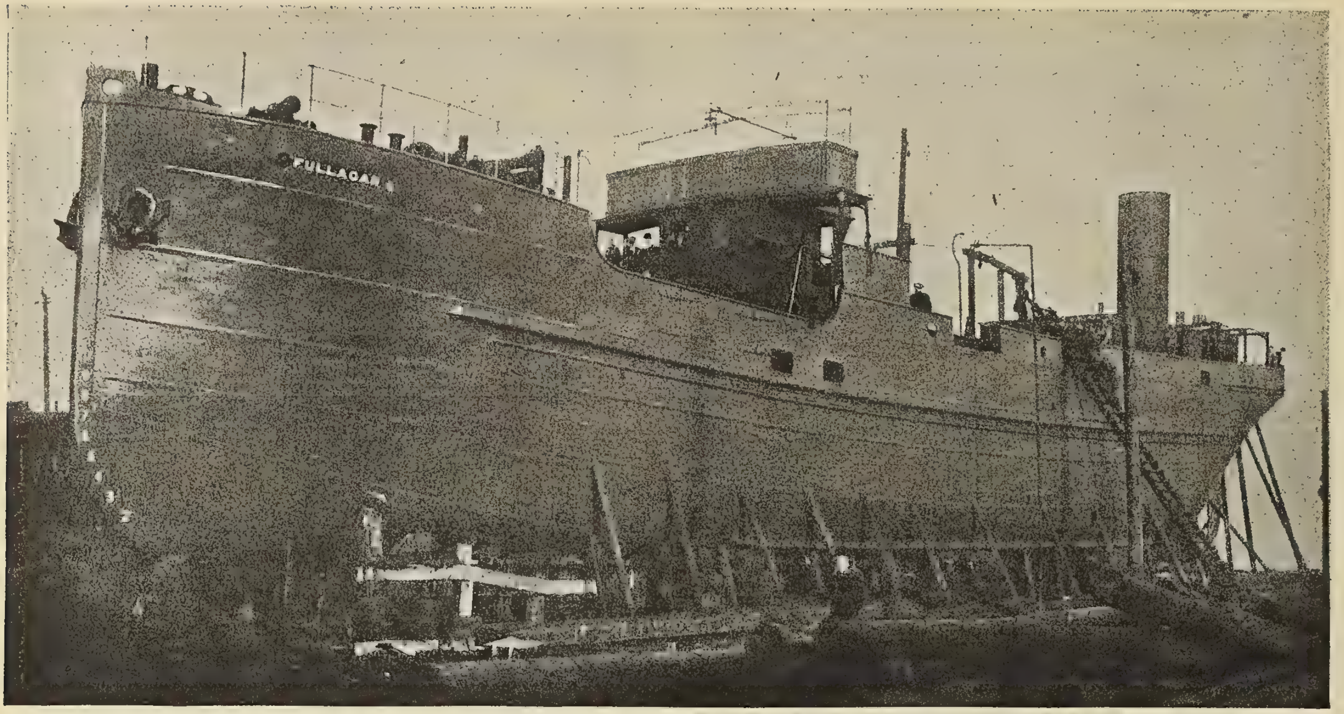


Fig. 9.—Electrically-Welded Coaster *Fullagar*, Built by Cammell Laird & Company, Ltd., Under the Quasi-Arc Welding Patents

inch by 1¼-inch angles, spaced 18 inches between centers; while her hull and deck plating are made of No. 8 steel in 4-foot by 8-foot and 4-foot by 10-foot sheets.

The keel, frames and deck house were riveted, while the hull and fore and aft deck plates were electrically butt welded to each other. Where the jointure occurred between frames or other suitable landing, the butt was reinforced by a backing strap.

Although unaccustomed to marine construction the builders completed the *Geary* in about 80 days, and have since continued to operate her as a floating repair boat in and about Ashtabula harbor. In the meantime the only difficulties experienced have been leaky rivet joints caused by ice jams and collisions, and these were quickly repaired by welding.

The Germans have been doing a great deal of electric welding on many of their ships, as evidenced by post-war inspections of the *Deutschland* and other submarines captured by the British fleet. No extended information regarding the German operations is as yet obtainable, however, but when known their methods will undoubtedly add much to our ethnology of welding.

British Welded Ships

It is to the English builders that we must doff our caps for persistent research and accomplishment in the line of electrically welded ship construction. Although relatively much smaller than our partly constructed American exhibits, and of later date, they have already produced two welded vessels which are worthy of special mention in any history of shipbuilding.

The first of these is the 200 deadweight-ton electrically welded cross channel towing barge, built at Richborough, and launched in May, 1918. Her dimensions are: Length between perpendiculars, 125 feet 9 inches; breadth, molded, 16 feet 4 inches; depth, molded, 7 feet 9 inches. In general, the middle portion of this barge is of rectangular cross section with curved bilges, deck curved stem, transom stern and two hatchways each 42 feet by 10 feet. She is provided with one fore and aft and one midship watertight bulkhead.

All plating and framing was assembled with service bolts, spaced 10½ inches between centers, which were afterwards removed and the holes filled with plugs and welded up flush. When completed, the barge was energetically employed, along with many others of similar type but riveted, in the transportation of ammunition between English and French ports, and, aside from occasional leakage through the plugged service bolt holes, has given excellent satisfaction.

The second example of English enterprise is the 500 deadweight-ton coasting steamer *Fullagar*, launched on February 5, 1920, at the Birkenhead yards of Messrs. Cammell, Laird & Company, Ltd. A side view of this ship is shown in Fig. 9.

The *Fullagar* is a single deck vessel with superimposed bridge and pilot house structure, and is fitted with the Fullagar-Diesel type engines. She is, to all intents and purposes, a completely welded ship, although the more or less extended use of tack and service bolts in the assembly of her frames and plating detracts somewhat from the possible advantage of electrically welded vessels erected without perforating any of the watertight members.

The particular purport of this paper has been to feature the simplifying effect of substituting welding for riveting in the construction of ships, as also the saving of weight and costs, by a few illustrations which may be accepted as typical of many other applications of that method of construction ashore and afloat.

If one were to calculate the number of square feet of shop floor space required per ton of ships' plates fabricated by the riveting process, likewise the number and cost of tools required, and compare the results with those required per ton of plates fabricated by the arc welding system, the showing would be almost unbelievable. Nevertheless, it may be safely predicted that the time is near when the equipment of a ships' plate fabricating shop will be practically limited to shears, rolls and welding generators. The only punches required will be those used for making the welding assembler's jigs, and we shall also have a few chippers and grinders for surfacing the finished welds.

TABLE III.—COMPARATIVE COSTS OF RIVETED AND WELDED OIL TANK FOUNDATIONS FOR 12,000 TON CARGO SHIPS.
Figure for Port Side of Hold No. 4 or ¼ of Complete Foundation

Ref. No.	DISTRIBUTION	RIVETED CONSTRUCTION		WELDED CONSTRUCTION	
1	Drawings		$50.00		$30.00
2	Template Work		150.00		30.00
3	Ship Fitters and Laying Out				40.00
4	Plate, Tee and Angle Shearing				46.80
5	Forge and Press Work		150.00	none	......
6	Planing			none	......
7	Punching			none	......
8	Drilling and Reaming			none	......
9	Countersinking			none	......
10	Rigging				14.00
11	Assembling, Erecting, Regulating and Bolting				35.00
12	Riveting		802.00	none	......
13	Gas Cutting				15.00
14	Packing and Leading			none	......
15	Chipping and Calking				15.00
16	Tank Testing			none	......
17	Welding: Incl. Power and Labor	none	......		1,310.35
18	Painting, Omit, as same for both		......		......
19	Add Quarterman separately for Riveting		150.00	See No. 17	......
20	Add Power separately for Riveting		50.00	See No. 17	......
21	TOTAL LABOR COST		*1,352.00		1,536.15
	MATERIALS REQUIRED	NET WEIGHT	COST	NET WEIGHT	COST
22	Plate for Girders and Brackets	7730	248.46	6004	200.00
23	Angles for Girders and Brackets	10480	308.94	none	......
24	Tees for Girders and Intercostals	none	......	7821	248.70
25	Rivets, Figured as 4,000 at ½ lb. ea. for Heads*	2000	200.10	none	......
26	Welding Wire	none	......	1175	94.00
27	TOTAL MATERIALS	20210	757.50	15000	542.70
28	GRAND TOTAL, LABOR AND MATERIALS	20210	2,109.50	15000	2,078.85

* Item 21 for Riveted Work was considerably increased by unexpected incidentals.

At the construction end we will require crane service and shoring for erection, but the work will be assembled, regulated and drawn to place absolutely equal to or better than the present "bolting up" system, *without a single perforation in the plating,* and with much less expenditure of time and materials.

This is no fanciful dream. It is perfectly feasible, and has been proven commercially successful. All one needs is to know how, and exercise sufficient ingenuity to improvise a method of dealing with each new condition as it arises. In this respect scientific welded construction is not one whit different from the successful bolter-up's method. It differs only in speed, cost and convenience.

It is not claimed that the actual welding of plating joints is more rapid or less expensive than riveting, but, considered as a whole, welded construction is more rapid and less expensive than the aggregation of operations which, together, constitute riveted construction.

And, when the work is complete, note the difference. By no possible means can a riveted joint be made stronger or more durable than the plate itself. With welding it is only necessary to increase slightly the area of section to obtain a joint having 100 percent plus efficiency.

The welded ship will afford great satisfaction to the ship's crew, with its complete absence of plate edges and billowy seams. What speed and free maneuvering the skipper can report because of the ship's perfectly smooth hull, and what satisfaction to the owners that a 5,000-ton ship can actually carry 6,000 tons of cargo due to the lesser weight of material required in her construction!

The methods and policies of our ancestors were good in their day only because they utilized such means as were then available. History records that the writer's grandfather operated his woolen mill from 1815 to 1830 with yokes of oxen; but, few and inefficient as they then were, during the latter year he installed a steam engine. No method should be considered *good enough* when competition and genius have developed something greatly superior.

It is an old saying, that history often repeats itself, and the recent report of the loss of the tanker *Mielero* by breaking in two in mid-ocean is a too oft-repeated tale. One of the greatest arguments in favor of the welded ship is its freedom from the weakening effect of punching its most important strength members full of holes for rivets. In the breaking up of practically every stranded ship it may be noted that the structure first gives way along the line of riveting which connects the midship bulkhead with outside plating, a jointure which almost completely encircles the hull. The loss of strength due to perforating a plate cannot be regained, even in part, by filling the hole with a rivet. *Moral.*—For safety, economy and durability, weld the ship!

Bronze Sleeve Welded on Propeller Shaft

In November, 1919, the Welded Products Company, of Birmingham, Ala., carried through a welding job for the Emergency Fleet Corporation that is of general interest to marine engineers, for it is apparently the first successful attempt at welding the joints of the bronze sleeves on a propeller shaft.

Fig. 1.—Two Bronze Bearings and Two Bronze Protecting Sleeves Autogenously Welded on Propeller Shaft, Making a One-Piece Sleeve 26 Feet in Length

In this case the shaft was 26 feet in length and had a one-piece bronze sleeve almost entirely covering it when finished. This sleeve was made up of two bearings and two sections for protecting the shaft. After the various sections had been shrunk on, the joints were autogenously welded together by means of the oxy-acetylene torch. The welding rods used were similar to composition *"G"* specified by the Navy Department.

Repairing Cast Iron Cylinders by Welding

BY COMMANDER H. G. KNOX, U. S. N.,* AND JAMES W. OWENS†

In this article the authors describe how a badly fractured large high pressure marine engine cylinder was successfully repaired by means of electric arc welding. Before taking up the details of this remarkable job, however, the advantages and disadvantages of the various other forms of welding are discussed from the viewpoint of their application to this class of repair work.

THERE are three forms of welding which are more or less suitable for the welding of cast iron, namely, thermit, gas and arc, and one of the requirements of the welding engineer is to decide which form should be used. In making his decision, it is necessary to bear in mind the following:

(a) Equipment available to do the job.
(b) Time available.
(c) Nature and location of break.
(d) Where welding is to be done (on shipboard or in shop).
(e) Cost as a determining factor.
(f) Relative suitability of each form of welding to obtain strength.

Thermit Welding

As it is well known, thermit is a mixture of iron oxide and aluminum combined in the proper proportions which on ignition combines with the evolution of an enormous heat to form a superheated fluid iron with an alumina slag.

A weld is made by tapping into the mold surrounding the fractured parts, steel as made by this reaction, which

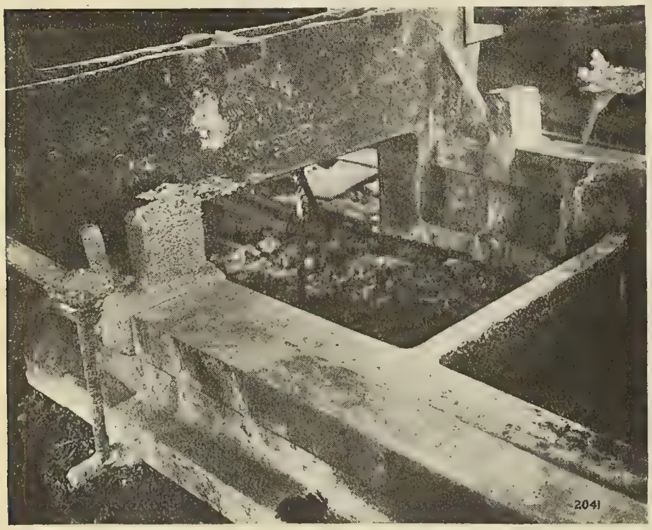


Fig. 1.—Iron Casting Welded by Thermit Process

as it flows between the fracture melts by reason of its excessive temperature (5,000 degrees F.) a considerable amount of the metal of the parts and cooling solidifies with the parts. In actual practice the reaction is tempered by the addition of mild-steel punchings, and the quality of the steel is improved by the further addition of manganese, nickel, etc. For the welding of cast iron, "cast-iron thermit" is recommended instead of "railroad thermit," which is usually used for the repair of steel and wrought-iron sections.

This form of welding is particularly suitable for the welding of large sections, and if the fracture is in such a section its use might be advisable, making it possible to complete repairs with the cylinder in place. Generally speaking its field of application for this class of work is limited, but on heavy sections it has the advantage over any other form of welding in the fact that the weld is all made at one time, and there is therefore, but one shrinkage, which, if properly allowed for, avoids the possibility of locked-up stresses and shrinkage strains. Fig. 1 shows the general method of making such a weld.

Gas Welding

At the present stage of development of cast-iron welding, there is no doubt that, generally speaking, from the standpoint of strength, gas welding should be used wher-

Fig. 2.—Engine Cylinder of S. S. *Neckar* with Patch in Place for Oxy-Acetylene Weld

ever possible, but its use on marine engine cylinders is limited by the following:

(a) The necessity for preheating, frequently requiring the cylinder to be dismantled and taken to the repair shop.
(b) The likelihood of setting up strains due to preheating in parts of the cylinder remote from the area under repair.
(c) The discomfort to the operator when welding on a large preheated job.
(d) The relative difficulty of welding with the same ease and reliability in vertical and overhead positions, as in flat or horizontal positions.

This method of welding cast iron has been in successful use for several years in large railroad shops. The section to be welded is brought up gradually to a "black" heat, either by the gas torch or a charcoal fire, depending on the nature and complexity of the job. After this is done a rod of cast-iron welding material is gradually melted by the torch into the V'd-out section, and then melted into the fused puddle under the torch tip, thereby

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† Welding aid and assistant shop superintendent, United States Navy Yard, Norfolk, Va.

Fig. 3.—Acetylene Weld on *Neckar* Cylinder Partly Made. Note Mounting to Keep Puddled Metal Horizontal

obtaining perfect cohesion and eventually closing the opening.

The best results are obtained when the weld is made horizontally, the metal being deposited from above. Good work has been done both vertically, and even overhead, by skillfully handling the torch, and at the same time aided by the use of carbon blocks and paste.

Fig. 2 shows the intermediate cylinder of the German ship *Neckar*, with the cast-iron patch in place. All the welding on this job was done in a "flat" position. To facilitate this a cradle was attached to the cylinder, which was rotated as the welding progressed (see Fig. 3).

The preheating of the section to be welded was done by a charcoal fire, the bed for which is clearly shown in Fig. 3. Fig. 4 shows the completed job, which on test showed no leaks whatever. Many examples of this class of work are being done throughout the country. One job recently brought to our notice had 27 linear feet of welding.

Electric Arc Welding

This form of welding has the advantage in that only the immediate section being welded is heated, and only at the time the metal is being deposited in the weld. Due to this the general strains in the casting are reduced to a minimum, and this method of welding should therefore be employed when the casting is a complicated one. It further has the advantage of permitting the work to be done on board ship with the cylinder in place, thereby saving time.

The welding of cast iron, however, by means of the electric arc (both carbon and metal arcs) does not give, as a rule, the cohesion and homogeneity attainable by means of thermit or the gas flame.

Fig. 4.—Oxy-Acetylene Weld Completed on Cylinder of S. S. *Neckar*

If the carbon arc is employed, the method of welding is similar to gas welding, the metal filler rod being fed into the arc instead of into the gas flame. Having almost the same limitations as the gas torch, the carbon arc is, to date, seldom used in marine cylinder work.

For metal-arc welding, the electrode usually used is a mild steel rod varying in diameter from ⅛ to ¼ inch, depending upon the size of the work. Phosphor bronze and cast-iron electrodes have also been used to advantage. Phosphor bronze is objectionable because of its low melting point and high coefficient of expansion. It is difficult to procure cast-iron electrodes of uniform homogeneous structure, which at the present time limits its use, but there is no doubt that, as this difficulty is overcome by improved manufacturing processes, and with the development of suitable fluxes, coatings, and coverings, its use will be greatly extended

Cast iron contains a high percentage of free carbon, and has a lower melting point than mild steel. When added, the free carbon of the cast iron unites with the lower carbon steel of the electrode, causing a layer of chilled high-carbon steel to be deposited in the weld at the junction of the electrode material with the cast iron. This is only about ⅛ inch thick, but, being brittle, the weld is easily broken. To overcome this difficulty, cast iron when welded by the electric arc is usually studded, ⅜-inch mild steel studs, ¾ inch long being the most commonly used.

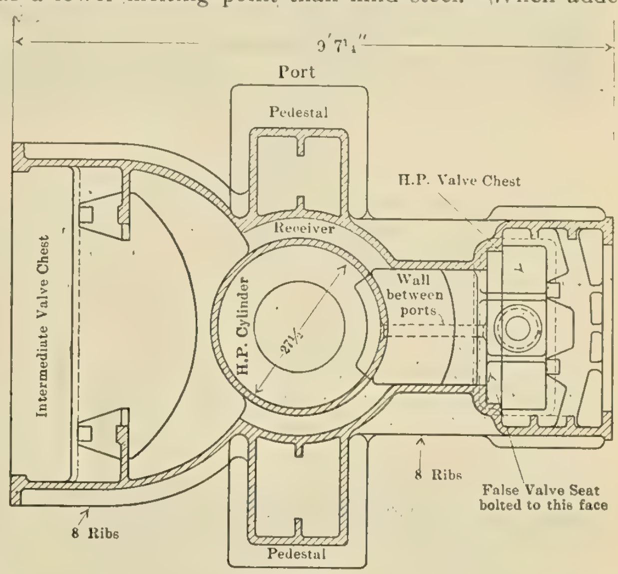

Fig. 5.—Section of Cylinder Showing Complicated Construction

This deposit of high-carbon steel also causes trouble, when it is necessary to machine the surface after welding as the tool will ride over hard spots and dig into the soft metal on both sides of it. This disadvantage may yet be overcome by the development of a more suitable electrode.

The Fractured Cylinder

Fig. 5 is a sectional plan of the high-pressure cylinder of the Dutch ship *Rondo*, and together with the other sketches of this cylinder gives some idea of its complicated nature.

It embraced, in the center, the high-pressure cylinder; on the right, the high-pressure valve chest; and on the left, the intermediate-valve chest (see Fig. 5). The receiver connecting these two valve chests forms an integral part of the casting and passes through the pedestal shown

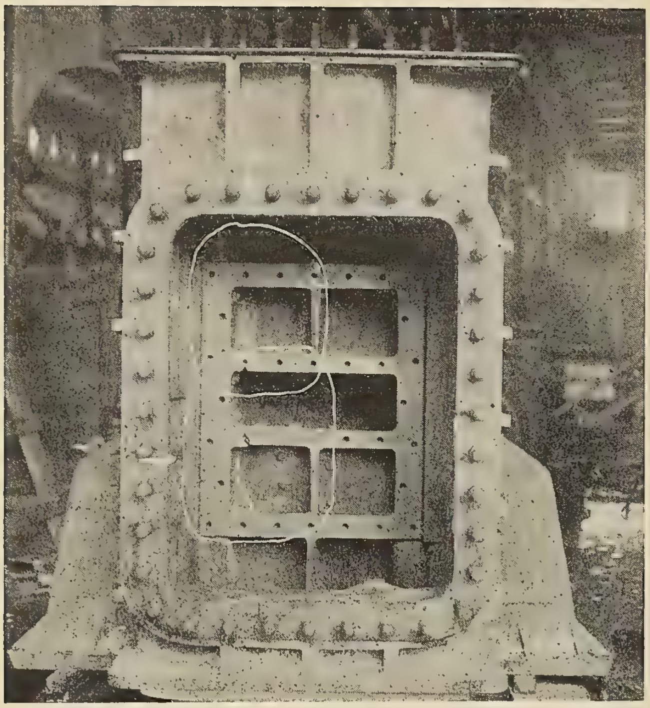

Fig. 6.—Cracked Valve Chest

in Figs. 6, 9 and 10. The valve ports *A* and *B* (Fig. 6) had been previously repaired by a welding company in March, 1918. Repairs were made by arc welding and by riveting a 10-pound plate and a 3½-inch by ⅞-inch steel bar to the port walls. After these repairs, two trips were made to Europe, but the leakage was too great to continue the high-pressure cylinder in service.

The *Rondo,* of 10,810 gross tons, built in Holland in 1914, was chartered by the United States Government. The diameter of high-pressure cylinder is 27½ inches, with a 53-inch stroke. The indicated horsepower of the engine is 5,100.

The mechanical and thermal stresses to which a weld in the port walls would be subjected to are:

First, a rapid change of pressure from 215 pounds in the high-pressure cylinder to between 40 and 60 pounds in the intermediate cylinder.

Second, a sudden change of temperature from superheated steam at 510 degrees to saturated steam at 307 degrees.

The Breaks

Figs. 6, 7 and 8 show the badly cracked steam-port walls on the starboard side, these having been welded as previously noted. Fig. 7 shows break 6-*A* enlarged, and Fig. 8 shows break 6-*B* enlarged.

These cracks were probably caused by a flood of water when the engine was being "warmed" up.

A circumferential crack about 20 inches long was found immediately over both the starboard and port pedestals (Figs. 9-*A* and 10-*A*). This was probably caused by a bending moment in the cylinder due to the overhang of the pedestals.

There was also an axial crack in the cylinder wall on the starboard side about 19 inches long, which extended through the top horizontal flange (Figs. 9-*B*, 14-*D* and 15-*D*). This was very likely due to a tendency to articulate on account of the extreme fore and aft length of the cylinder, or it occurred in the removal of the "frozen" liner, which eventually had to be chipped out its entire length for removal. There was one other axial crack on the starboard side of the pedestal (Fig. 9-*C*), probably due to surface shrinkage. This was not serious, as it was not welded and did not leak when the cylinder was tested.

Preparation for Welding

The port walls to be repaired were entirely cut out (Fig. 11). An oval access hole 12 inches by 18 inches (Figs. 11-*D*, 12-*D* and 15) was cut in the cylinder wall, in order to

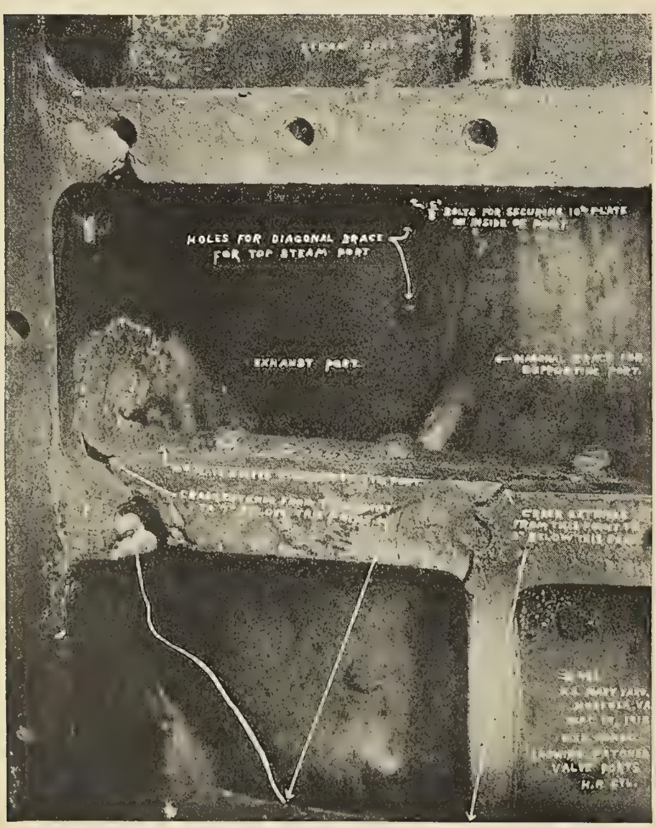

Fig. 7.—Enlarged View of Break "A," Fig. 6

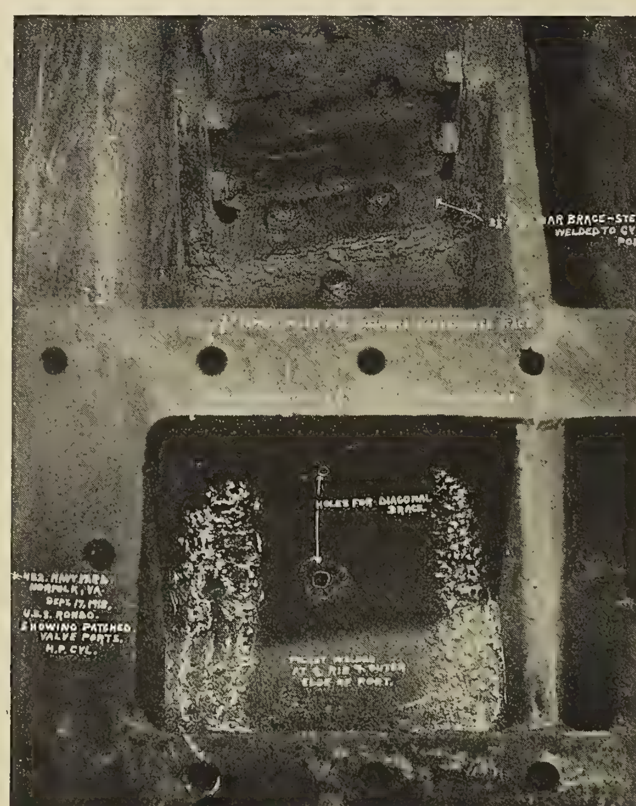

Fig. 8.—Enlarged View of Break "B," Fig. 6

Fig. 9.—Cracks, Starboard Side

weld the new port walls in place as shown in Figs. 13-*A* and 17-*A*.

The exact length of the cracks in the cylinder walls was determined by sand blasting. A hole was drilled at the ends of each crack before chipping out to a 90-degree bevel. All bevels, valve-port walls and the hole in the cylinder wall, were studded and a ¼-inch calking groove 3/16 inch deep cut longitudinally between the studs for steam tightness (Figs. 12 and 18).

Patterns, Fig. 16, from which steel castings were made, were fitted for the new-valve port walls and for the patch in the cylinder wall.

Technique Followed in Welding

Direct current, 70 volts (open circuit), 120 amperes and ⅛-inch bare electrodes were used.

Fig. 10.—Cracks, Port Side

The calking groove was carefully welded, the studs surrounded with metal and the intermediate surfaces gradually filled up until the electrode material deposited was flush with the top of the studs (Figs. 13 and 18). Both surfaces of the bevel were at the same time built up (Fig. 18).

Patches were not put in place until a ½-inch pad of electrode material was built up on the cast-iron surface to which they were to be attached (Figs. 13 and 19). A handle was welded to each patch to facilitate its being put in place (Fig. 14-*B*).

Fig. 11.—Ports Cut Out Before Welding

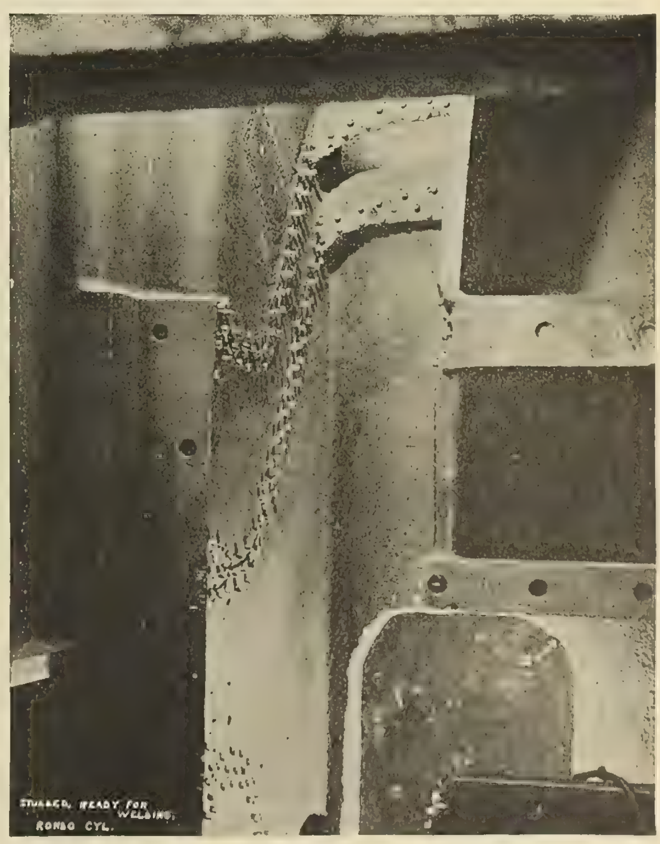

Fig. 12.—Cylinder Studded, Ready for Welding

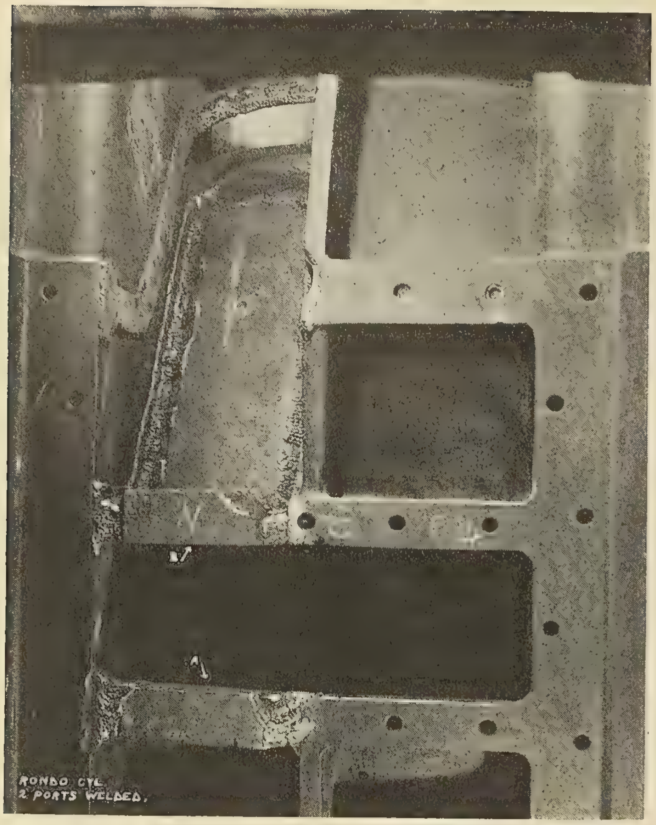

Fig. 13.—Two Ports Welded

As a patch was put in, it was tack welded, and great care was used to avoid overheating of a local section.

As soon as the temperature of the metal two inches from the weld rose above what the bare hand could stand, welding was moved to another spot. Even with this precaution an occasional section of deposited metal had to be chipped out. The oxide deposited on layers was removed by means of a hand brush before additional layers were put on.

Fig. 14.—A and D, Cracks Welded. BB, Two Patches

Fig. 15.—Position of Welds Inside Cylinder

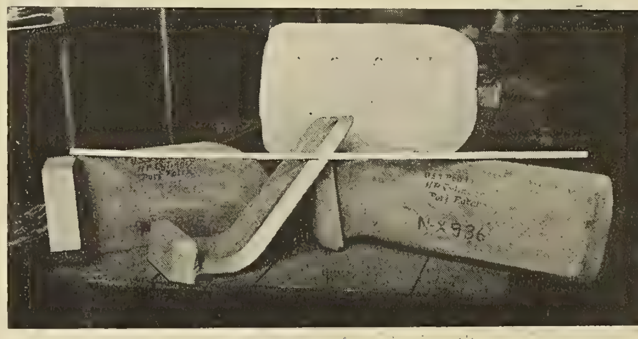

Fig. 16.—Patterns for Patches

Fig. 17 shows a cross section through the valve ports and chest, and the side of the steam-port wall on which a bevel was made for welding. Wall *A* was the first one put in place and welded by the operator working from the inside of the cylinder, through a hole cut for this purpose. Wall *B* was the next one, and finally wall *C*. Fig. 13 shows *A* completely welded, *B* partly welded, and *C* not yet in place. After this was completed, patch *D* in the cylinder wall was welded.

Tests

When the ports were faced off for the false valve seat, the section of hard-welding material referred to earlier in the article caused the cutter to cock out and cut into the softer cast iron. This was particularly bad in two cases and was remedied by beating down the ridge with a hammer. When hammering was not effective a small "V" section was chipped out, a ⅜-inch hole drilled and a mild steel stud inserted, which was machined off flush (Fig. 20). A little magnesite was put in the chipped out "V" when the false valve seat was put in place, and together with the stud formed a steam-tight joint. In subsequent work of this kind, the "V" left after the hard spots are chipped out has been filled up using a bronze electrode. As the bronze does not harden in cooling, the surface may be readily machined.

The cylinder was given a series of tests in the shop to determine its steam tightness. To do this, it was set vertically, the heads put on top and bottom, the ports blanked off, a steam-line run to the top head and a water line to the bottom one.

Water was now pumped in and the temperature gradually raised to 150 degrees by forcing steam through it for a period of five hours. At the end of this time, the hydraulic pump was started and the pressure gradually

raised to 50 pounds in five minutes, which, however, could not be increased beyond this point, as the seepage was too great in nearly all the welds. The pressure was now reduced, some sal ammoniac dissolved in the water and allowed to stand for a few hours.

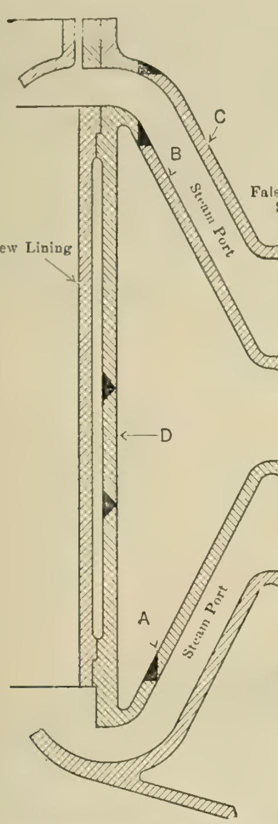

Fig. 17.—Section Through Valve Chest

It might be mentioned here that at least one large automobile manufacturing company uses sal ammoniac to stop porosity in the cylinders of all their cars, both passenger and motor truck. The cylinder is filled with a dilute solution of sal ammoniac in water and baked in an oven for several hours.

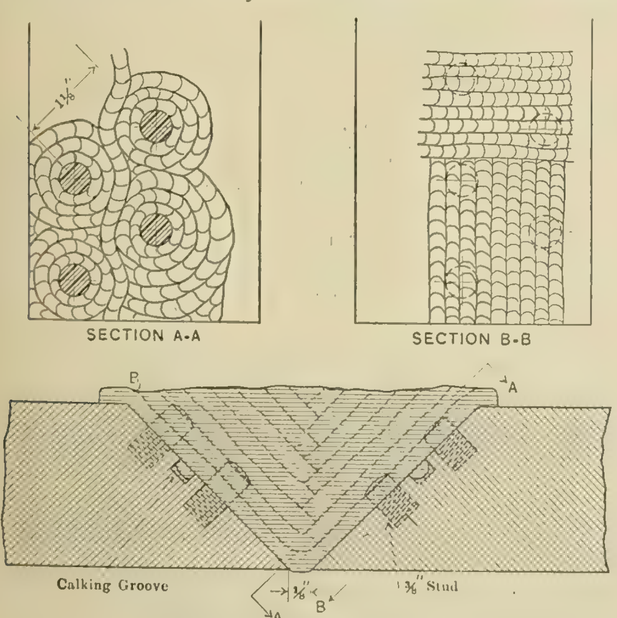

Fig. 18.—Preparations for and Methods of Welding

After the sal ammoniac treatment, a steam test was applied, the pressure being raised to 225 pounds, at which point it was cut off. Only a few small leaks were observed.

The last test applied to the cylinder was after assembly on board the ship, when it was observed during a dock trial. The engine was warmed up for 10 hours before

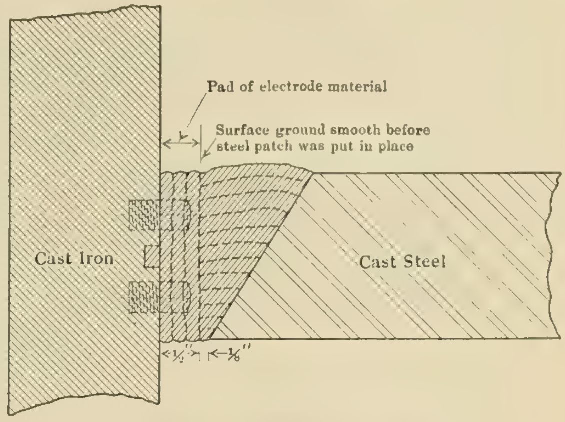

Fig. 19.—Method of Welding

being started, and then run with 110 pounds boiler pressure. The welds in the walls showed a little porosity in two spots, one on the starboard and the other on the port side of cylinders; but this soon disappeared.

An indicator card of the high-pressure cylinder taken at this time showed that the valve ports were essentially steam tight (Fig. 21).

An indicator card of the high-prssure cylinder (Fig. 22) was taken on the last trip to Europe, previous to docking for repairs. When compared with cards taken at the same time for the intermediate- and low-pressure cylinders, it showed only about one-half the indicated horsepower of either one. Approximately the same horsepower was expected, if the valve ports were in good condition.

No good comparison can be drawn from these cards, as the card shown in Fig. 21 was taken alongside the dock at 110 pounds pressure, and the card shown in Fig. 22 was taken at 210 pounds pressure at sea. Both cards were taken with a 100-pound spring. A card taken under similar conditions to Fig. 21 is not available.

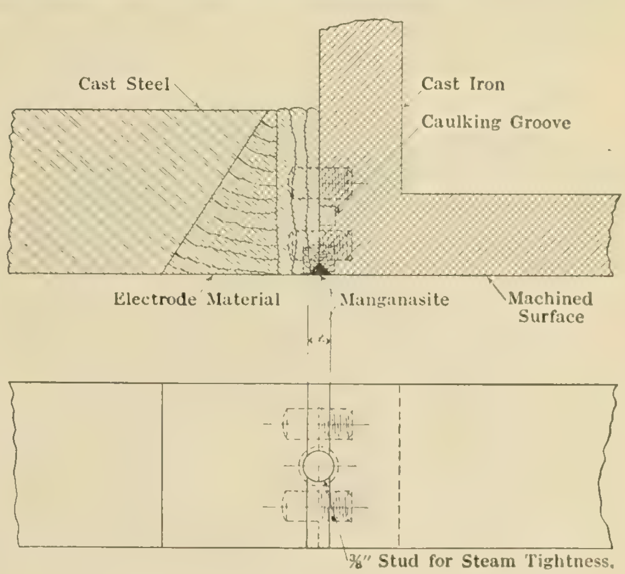

Fig. 20.—Method of Making Weld Steam-Tight

The ship left the Norfolk Navy Yard on December 21, 1918, and on February 24, 1919, the engineer wrote as follows:

"Horsepower-valve chamber was examined after a run

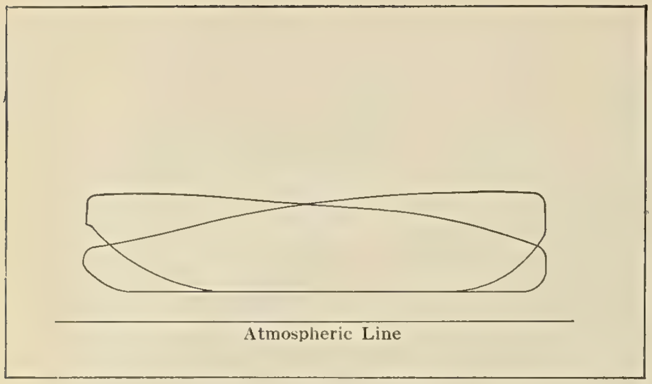

Fig. 21.—Indicator Card of High Pressure Cylinder Taken at Dock Trial with Ports Repaired

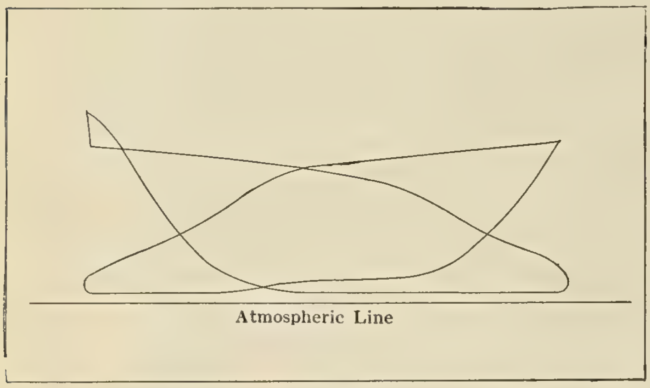

Fig. 22.—Indicator Card of High Pressure Cylinder Taken at Sea with Ports Broken

of 5,850 miles. The welding and patches put on at the Norfolk Navy Yard show no signs of working, and are in good condition at the present time."

Comparative Time and Cost

The labor and material of welding cost approximately $1,870 (£384), the items being:

(1) Welding and preparation for welding....	$1,760.00
(2) Patterns for patches....................	60.00
(3) Casting of patches.....................	50.00
	$1,870.00

Shipbuilding Gives Great Impetus to Oxy-Acetylene Industry

Process Plays Big Part in Present-Day Yard

BY RUFUS COPELAND

Unprecedented building of ships in United States shipyards has resulted in a remarkable stimulus to many related industries. Referring casually to the effect of America's shipbuilding program on the oxy-acetylene industry, an official of the Oxweld Acetylene Company, probably the largest manufacturers of oxy-acetylene blowpipes and generators in the world, said recently, "Our business has grown enormously the past few years, primarily as a result of the adoption of oxy-acetylene cutting and welding in practically all branches of manufacture, where the processes enter more and more into production as elements of economy and speed, often superseding methods that had long been considered the ultimate in manufacturing efficiency. This has been observed notably in the shipyards of the country, and has

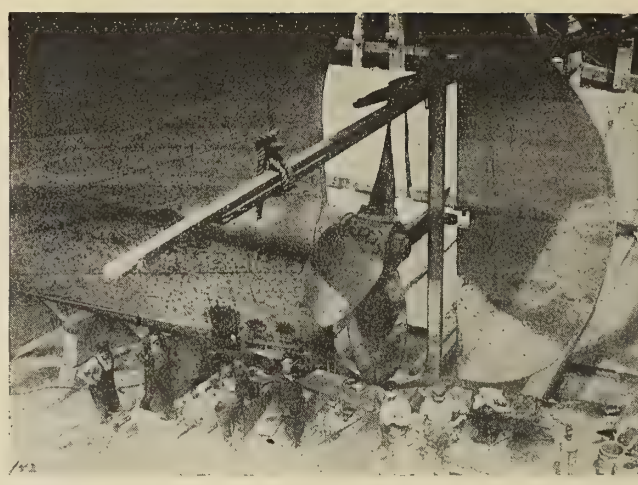

Fig. 1.—Cracked Stern Post Repaired in Seven Hours by Two Operators

contributed in an appreciable degree to the amazing increase in American shipbuilding activities."

Another authority, speaking of the Linde Air Products Company and the gas division of the Prest-O-Lite Company, each of which is national in scope and service, said, "While the great increase in the use of oxygen and acetylene gases is a result of the wider application of oxy-acetylene processes in general industry, growth in ship-

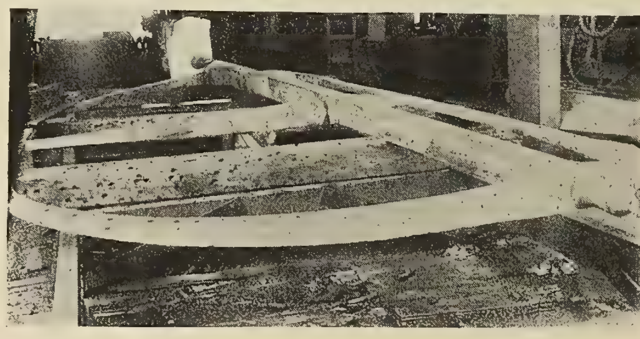

Fig. 2.—Forged Steel Rudder Frame

building has been an important factor in the recent development of these businesses."

The accompanying pictures show welding operations that a few years ago would have been considered remarkable. To-day they are but minor operations in an application of oxy-acetylene to present-day shipbuilding, and as such are typical of common, everyday work in the average shipyard. Fig. 1 shows a stern post that was cracked by scraping on a shoal. The post is seven inches thick and weighs 28 tons, and the crack was 11 inches

Fig. 3.—Anglesmith Work Done by Oxy-Acetylene Welding at Oscar Daniels Shipyard, Tampa, Fla.

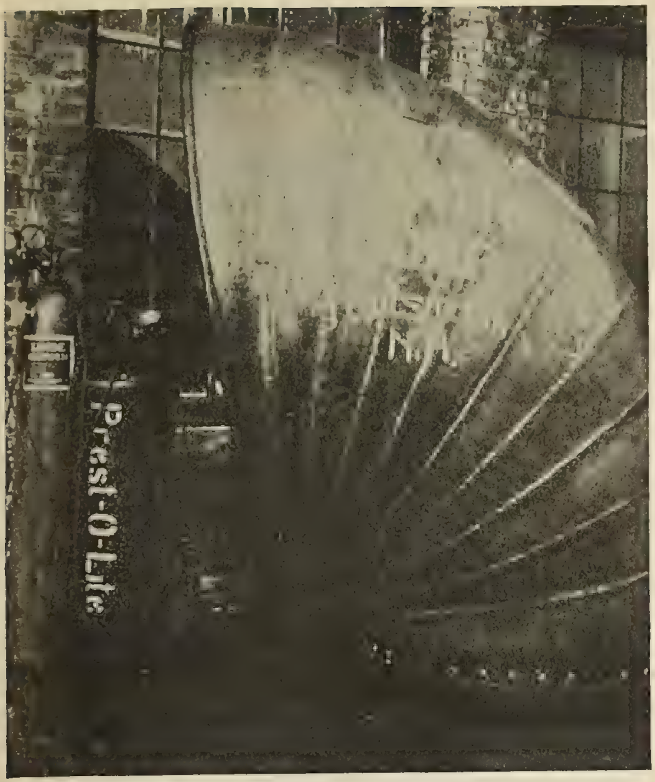

Fig. 4.—Welded Ventilator Cowl

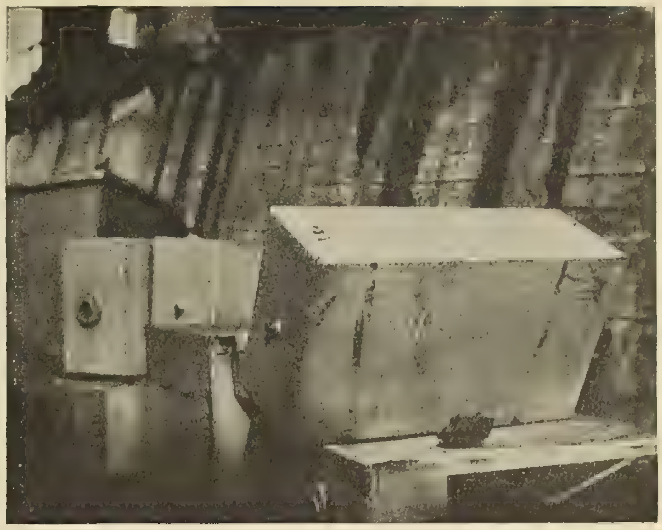

Fig. 5.—All Welded Oil Tanks, Toledo Shipbuilding Company, Toledo, Ohio

long, extending vertically. It was repaired in seven hours by two operators. Fig. 2 represents a three and a half-ton steel rudder frame, valued at $1,200 (£257). It was cracked and successfully welded in two places. Fig. 3 shows anglesmith work done by welding. Fig. 4 is a welded ventilator cowl. Fig. 5 is an example of all-welded oil tanks.

The only difference between these operations with oxy-acetylene and those of a few years ago is the fact that they are welding jobs. The use of oxy-actylene for cutting is somewhat older in accepted shipyard practice. Fig. 6 shows a minor operation of this type.

Oxy-acetylene in its application to shipbuilding, therefore, is not new. Prior to the war it was used extensively, though not so extensively as to-day, in the cutting division of the industry.

Among the uses to which it is devoted, and which have been authorized by the American Bureau of Shipping, may be enumerated the following—a considerable and constantly expanding list:

WELDING

Ventilators and all light-gage air ducts leading from ventilators to ship compartments; smokestacks, boiler uptakes and boiler casings made of light-sheet steel; deck-rails and deck-rail supports (several hundred supports and hundreds of feet of pipe railing to each ship); ladders (welded ladders much stronger than bolted ones, affording greater strength to tread and security from accident); stairways, floor grating, bulwarks, skylights, frames and casings, hinges, tanks, hatch covers, mast seams, coal chutes, castings, manhole rings, channel and Tee bars, "I" beams, flange-steel tubing, davits, stanchions, bushings.

Tanks of every nature are welded, notably lubricating oil storage tanks, fresh-water tanks, reserve oil tanks, food-storage boxes, etc. Welding is also used in attaching ventilator and smokestack deck collars, and for butts of watertight and oiltight boundary bars on bulkhedas or floors in double bottoms. Engine and boiler room flooring is laid on welded supports. Cleats and other fittings are welded to angles or plates.

CUTTING

Ventilators (cutting plates to shape for welding of ventilators, tanks, etc.); angles for subsequent welding into staples, etc.; holes in plates, frames, manholes, chains, mast openings, stairway openings, channel openings, angle irons, shafting, channel irons, pipes, stem and stern posts, headlights, scrap.

HEATING

Plates, channel irons, rivets; also for bending angle and channel irons and repair work in connection with damaged vessels, damaged plates and braces, machinery, and for cutting rivet heads and filling of misplaced punch holes.

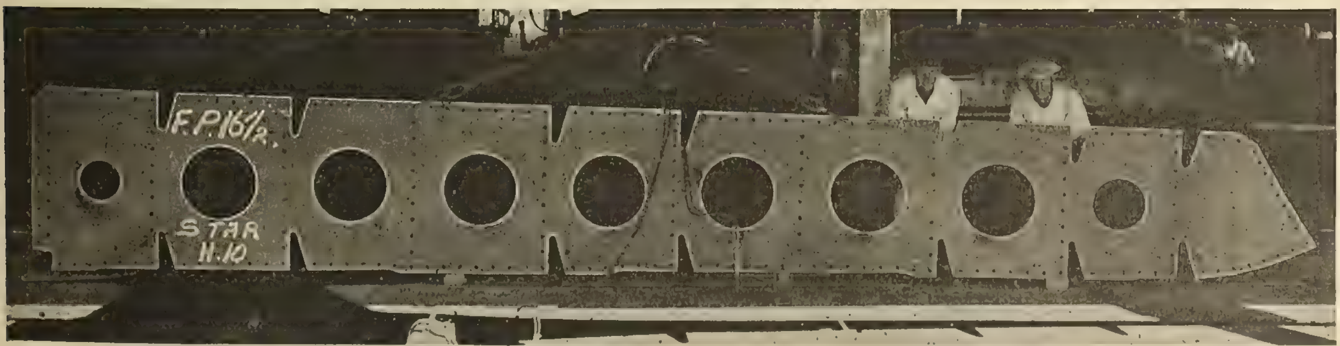

Fig. 6.—Floor Plate Cut with Oxy-Acetylene Torch, Oscar Daniels Shipyard, Tampa, Fla.

Permissible Ship Welding

BY WILLIAM T. BONNER*

PREVIOUS to November, 1917, electric welding had not been officially recognized by either of the principal classification societies and, if we may except a few special permits for specific undertakings of minor importance, no really serious consideration was given to welding as a means of constructing ships.

During the greater part of 1916, the writer was engaged in research work in connection with the development of various forms of jointures for ships' plating, including not only the conventional riveted seams prescribed by Lloyds and the American Bureau of Shipping, but every form of lap and butt weld within the limitations of electric arc, resistance or "spot" welding, and the fused jointures made with gas flame.

While these investigations were made, primarily, in the interest of certain operators who wished to determine which of the many types of jointures were most efficient and durable for their ships, the door was kept constantly open for the admission of the classification societies, that they might also note the results and be prepared to supplement their rules with permits to use such forms of welding as should prove dependable.

One important section of the above research embodied a series of tests carried out under the direction of the writer, at the Bureau of Standards in Washington. These were not of the usual laboratory sort. Each sample tested had been built in a shipyard by regular workmen, in strict accordance with Lloyds rules and with standard specification materials. The results, therefore, were regarded by Lloyds as dependable to the extent of determining values for welded jointures within the limitation of careful workmanship. Very early, however, it was found that the personal equation had much to do with the dependability of a weld, and while certain safeguards have since been devised for avoiding the ordinary dangers it must be admitted the latest lists of permissible welding are not as extended as they might be were our welders universally capable and honest.

Under date of November 9, 1917, the writer, then engineer of welded ship construction for the Merchant and Chester Shipbuilding Corporations, formally submitted for approval by Lloyds the following list of parts which he had prepared as typical of what should be regularly fabricated by welding. In a covering letter of November 16, 1917, the writer, referring to this list, stated:

"The basic principle upon which we have built above list insures the maintenance of all weather decks, plating and casings free from piercing for rivets, etc., and provides increased strength by the several increments of weld material. * * * It is with greatest confidence, therefore, that we submit aforesaid list as *suggestions* and ask your approval of our recommendation that they be fabricated by electric welding as far as the design of ship and conditions of construction permit."

In response to the above letter, Lloyds addressed the writer, under date of November 19, 1917, as follows:

"As requested during your recent visit, we have carefully considered the list of ships' parts which you would suggest electrically welding in the ships now building by the Chester Shipbuilding Corporation, and have pleasure in returning to you a copy of this list, having indicated thereon by means of an asterisk the items which we are prepared to accept as electrically welded, providing the welding be done to the complete satisfaction of our surveyor."

The following is a verbatim copy of the original list as submitted by the writer to Lloyds on November 9, 1917, even to the inclusion of the typographical error in the sixteenth* item, which was inadvertently written as "Door Frames to Casing, Hinges, Catches Hold Each-Hooks, etc.," instead of "Door Frames to Casing, Hinges, Catches, Hold-back Hooks, etc."

Incidentally it has afforded the writer considerable amusement and no little satisfaction to note that for more than two years the various publishers of this "standard list of weldable ships' parts" have, one and all, sent it out "as is," apparently with no thought as to its proper meaning.

Ships' Parts Suggested for Electric Welding

All coamings for hatches, bulkhead doors, etc.
Corners of all O. T. hatch coamings.
Hatch cleats to coamings.
*Deck rail stanchions to plating.
*Clips for detachable rail stanchions.
*Continuous railing rods (joints).
Attaching doubling plates.
* " deck collars (L-rings) around ventilators.
" " " " blow-off pipes.
* " " " " smoke stack.
* " cape rings " " pipes, etc.
* " galley fixtures to plating.
* " bath and other fixtures in officers' quarters.
* " cowl supporting rings to ventilators.
" L-bar clips to deck for bulwark stanchions.
" All fixed manhole covers to tank top and deck plating.
Fabricating base and cap L-rings for 'tween deck pillars.
Attaching pillar bases and caps to plating.
*Bulwark rail top splicing and end fitting.
Fidley top plating joints.
Engine and boiler room casing above trunk deck.
Coaling hatch frames.
Attaching cleats and other fittings to ditto.
Skylights over engine room, galley, etc. frames and covers.
* (a) Engine room stairs and gratings.
* (b) Boiler " " " "
*Attaching (a) and (b) to plating.
*Grab rods on casing.
Engine and pump room chairs and brackets.
Mast brackets to deck and mast—with supplementary rivets, if required by inspector.
Winch and windlass brackets and supports.
Attaching hawse pipe L-ring to deck.
Smoke stack casing foundations and brackets.
*All stairs and ladders including rail attachments.
*Door frames to casing, hinges, catches, hold each-hooks, etc.
Davit sockets to deck.
Bracket supports for davits.
Chain locker casing, foundations and fittings (eye pads to have supplementary rivets, if required by inspector).
*Clips for attaching interior wood finish to casing.
Deck house casing—companion ways, etc.
Filling up drop holes.
Bilge bracket gusset braces.
Flanges on steam and hydraulic piping.
Bollards, fairleads and mooring pipes.
Deck cleats and chocks.
*Entire screen bulkhead.
*Also coal chutes.

At various times during the two years following the issuance of the above list the classification societies accepted for approval applications from shipbuilders to weld additional parts in order to meet unusual war conditions, and because of further developments in the welding art. In the meantime Lloyd's British offices were giving constant attention to the development of welding and, as a result of their findings, the following circular (No. 1328) was issued by the committee, under date of October 6, 1919, as the official list of weldable parts in vessels building to the Society's classification.

Deck rail stanchions to plating.
Fastenings for detachable rail stanchions.
Joints of continuous railing rods.
Attaching deck collars (L-rings) around ventilators.
Attaching deck collars (L-rings) around funnel.
Attaching cape rings.
Attaching galley fixtures to plating.
Attaching bath and other fixtures in officers' quarters.

*Engineer, welded ship construction, member Society of Naval Architects and Marine Engineers, member American Bureau of Welding and American Welding Society.

Attaching cowl supporting rings to ventilators.
Butts of bulwark rail.
Skylights over galley.
Engine room skylights.
Engine room stairs and gratings.
Boiler room stairs and gratings.
Attaching engine and boiler room stairs and gratings to plating.
All stairs and ladders, including rail attachments.
Door frames to casings, hinges, etc.
Clips for attaching cleating to casing.
Entire screen bulkhead.
Coal chutes.
Butts of water-tight and oil-tight boundary bars on bulkheads or floors in double bottom.
Ventilator cowls.
Funnels and uptakes.
Bulkheads (which are not structural parts of the ship).
Partition bulkheads in accommodation.
Framing and supports for engine and boiler room flooring or gratings.
Cargo batten cleats.
Tanks (which are not structural parts).
Hand rails on exterior and interior of deck houses.
Deck houses not covering unprotected openings through weather decks.
Reinforcing and protecting angles around manholes.
Joints of water-tight angle collars at frames in way of water-tight flats.

In their circular (No. 1328), it was specified that no restriction be made regarding the system of welding employed, providing the local surveyor be satisfied as to its efficiency.

Following the provisions embodied in their previous regulations concerning welding, it was further stipulated that proposals to weld electrically any other parts of a vessel should be submitted to their head offices for approval, with the intimation that such proposals would be, in general, "granted only provided the arrangements proposed are considered to be satisfactory, and the system of welding intended to be employed has been recognized by the committee as complying with the prescribed regulations and tests."

The foregoing list is now accepted by the classification societies and by shipbuilders generally as the official list which may be followed in the issuance of specifications for electrically welding parts of merchant vessels. It should be borne in mind, however, that even though electrically welded ships' parts may have been "passed" by their local inspectors or surveyor, such approval is regarded merely as a "tentative measure" for classification of the vessel in Lloyd's Register as "experimental" or "electrically welded." (See Section 74, Lloyd's Rules for 1919-20.)

As in the past, the United States Navy Department still follows somewhat different lines in its acceptance of welding, and its latest ruling in the premises, covered by Navy Department Letter No. 58520-z-124 of February 12, 1920, Bureau of Construction and Repair, embodies what may now be understood as the official list of permissible welding on ships for the Navy.

For convenient reference the various interpretations and classifications of items have been grouped under four headings, as follows:

First—*Welds Permitted Under Well Guarded Conditions.*
Welding thin to thick plates, as, for instance, thin flues to thick tube sheets.
Welding rigidly fixed members with little or no opportunity for expansion and contraction.
Welding together materials of different physical characteristics, as, for instance, mild to high tensile steel.
Welding accessory members to hull plating while ship is afloat.

Second—*Recommendations.*
8. It is generally recommended that welding operations be centered first on shop fabrication, leaving work on ship for secondary consideration.
9. That welds be confined, as far as possible, to tee or corner fillets. Also that lap joints be used in preference to butts.
10. That special care be given to the sequence of welding.
11. It is intended that where welding is desired on new construction, it must be shown on plans, definitely marked, and covered by note to insure criticism in connection with approval of plans.

Third—*Welding Not Permitted.*
12. Welding shapes, plates or fittings to high tensile or special treatment steel members.
13. Welding high tensile steel members to each other.
14. Welding special treatment steel members to each other.
15. Welding in transverse lines, i. e., transverse members to longitudinal members, whether of medium steel or not.
16. Welding plates which form bracket plates, as, for instance, split bulkhead stiffeners.
17. Welding awning and rail stanchion feet to deck. (See item 48 for stanchion fittings.)
18. Strength members in general.
19. Welding any longitudinal strength member, such as:
Stringer plates.
Stringer angles.
Longitudinal angles.
Longitudinal and vertical keel angles.
Longitudinal bulkhead angles.
Butts of longitudinal plating, such as longitudinals, shell, deck and stringer plates.
20. Emphasizing item 18.

Fourth—*Welding Approved by the Bureau of Construction and Repair for New Construction.*
23. *Heading: Doors, Hatches, Manholes, Skylights, Air Ports, etc.*
24. Handles for doors, hatches and manholes.
25. Hinge, hook and brake pads for doors, hatches and manholes.
26. Flanged retaining bar for rubber gaskets for doors, hatches and manholes.
27. Stiffening angles for doors, hatches and manholes, provided these angles are cntinuously welded at their ends, where same butt against bounding angle of the floor or hatch cover.
28. Non-watertight doors, frames to bulkheads.
29. Engine room skylights, except attachment to deck.
30. Window frames.
31. *Heading: Miscellaneous Fittings for Storerooms, Compartments, etc.*
32. Miscellaneous clips to decks and bulkheads, such as stowage members, mess table attachments, etc., all subject to limitations prescribes in items 11 and 19.
33. Bathroom attachments.
34. Galley fixture attachments.
35. Gratings.
36. Pipe hangers, where applicable.
37. Ash hoppers.
38. Ladders.
39. Pads, grab rods, lacing hooks or eyes.
40. Ammunition racks.
41 Storeroom shelving.
42. Drain wells.
43. *Heading: Hatches.* (See item 23.)
44. *Heading: Manholes.* (See item 23.)
45. *Heading: Piping.*
45. Low pressure built up steel pipe and fittings, including drainage system.
46. Ventilators, cowls and ducts.
47. Watertight and non-watertight ventilation piping.
48. *Heading: Stanchions, Deck, Awning, Rail, etc.* (See item 17.)
49. Hooks on awning, rail and life line stanchions.
50. Head casting on awning stanchions to carry awning rope.
51. Structural:
52. Butt welding transverse bulkhead bounding bars in lieu of joggled bars or bosom bars. Above subject to following conditions:
53. First—Longitudinal strength bulkheads are wholly excepted.
54. Second—Where double bounding bars are fitted, butts of opposite bars must be well staggered.
55. Third—Bounding bars of watertight floors in double bottoms are wholly excepted.
56. Seams and butts of bulkhead plating, when bulkhead is of light or non-watertight construction.

57. Stiffeners to bulkhead plating conditional as under item 56.
58. Channels, built up from angles and flats.
59. Minor foundations.
60. Torpedo tube foundations, except attachment to deck.
61. Deck houses.
62. Air locks.
63. Flanged or dished plate corners.
64. Range finder platforms.
65. Searchlight platforms.
66. Pocket recesses.
67. Angle ring butts.
68. Welding stiffening rings to plates for bolting covers over openings. (This subject to approval of superintending constructors.)
70. Fabricating plate and angle staples.
71. Swash plates.
72. Hatch trunk butts.
73. Pipe tunnels.
74. Shaft tunnels.
75. Wiring tunnels.
76. Windshields.
77. Miscellaneous.
78. Attachment of half rounds, half ovals, etc.
79. Welding splice plates to angles to increase width of latter for attachment of fittings for tightness rather than strength.
80. Tanks, lockers, etc.
81. Stowing boxes for cleaning gear.
82. " " " flag.
83. " " " life preserver.
84. Chutes, such as coal and slop.
85. Ash hoppers.
86. Bread lockers.
87. Miscellaneous lockers.
88. Vegetable lockers.
89. Tanks, separate, up to 10 pounds pressure.
90. Tanks, gravity, for fresh water.
91. Transoms.

Like many other worthy movements the welding art has suffered most at the hands of its friends. Unfortunately for the best interests of welding many of its more enthusiastic advocates have urged the building of structures much beyond the proper capacity of their organization and equipment. The use of spot welding for fabricating the heavier framing members of ships appealed very strongly to certain of the builders engaged on work for our merchant marine, but it is very doubtful if the salvage value of the remaining scrap equipment will reduce the cost of those experiments to $100,000.

The persistence with which the 10,000-ton electrically welded ship was exploited called for exceptional reserve on the part of the Emergency Fleet heads who had to account for the millions being expended for ships, and who, fortunately, had practical knowledge of the uncharted rocks in the course of new ventures.

Making haste slowly has proven particularly beneficial in the development of this new method of ship construction, for it has enabled builders gradually to readjust their personnel and accumulate sufficient mechanical equipment for its proper conduct.

These have been very necessary preliminaries which, fortunately, are now accomplished; and there appears to be nothing in the way of attempting the larger problems provided, of course, the constructor has a well-organized welding plant and a sufficient number of competent, conscientious welders to carry out the work promptly.

Repairing Ships by Thermit Welding

The value of thermit welding in connection with realinement and other general utility work on large marine castings, in addition to its more frequent use in repairing fractured stern frames, rudder frames, etc., is well demonstrated in the case of two unusual thermit welding repairs recently made at the Brooklyn Navy Yard, New York.

Figs. 1 and 2 show an interesting double weld made on the cast steel rudder head of the steamship *Leopoldina* (formerly the *Blucher*), belonging to the Compagnie Générale Transatlantique. The whole purpose of this job was to repair the rudder stock, the upper part of which had to fit into a key-way on the rudder head. In order to make the repair it was first necessary to remove the rudder stock from the rudder head. The two sections, however, had become so tightly locked together that it was finally decided to separate them by cutting through one side of the rudder head with an oxy-acetylene torch. The rudder head was then removed.

Fig. 1.—One Side of Rudderhead Partly Cut Out by Oxy-Acetylene Torch

In repairing the rudder head it was necessary to cut through the side opposite the first oxy-acetylene cut in order to make two welds instead of one, and thus later equalize the effect of contraction when the welds had cooled. Having done this the two parts were lined up together so as to leave small gaps at the oxy-acetylene cuts.

A yellow wax pattern was then applied to the space formed by the gap and shaped around the adjacent portions of the casting in the form of a collar. The next operation consisted of building a mold around the wax pattern and then burning the wax out of the mold by means of gasoline (petrol) torches. The gasoline (petrol) flame also served to preheat the parts of the casting near the welds, in order to provide a more uniform contraction when the welds cooled.

Fig. 2.—Thermit Welds on Rudderheads After Removing Risers and Pouring Gates

As the position of the pouring gate steel shows in Fig. 1, both welds were poured simultaneously, using 350 pounds of thermit. Excellent welds were obtained and the cross-

head quickly returned to service. It is interesting to note that, as this repair was urgent, only 9 to 10 hours of working time were required to complete the welding operation.

Fig. 3 shows a thermit weld made on the starboard propeller strut of the United States torpedo boat destroyer *MacDougal*. This work was remarkable for the accurate allowance made for the contraction of the weld. The cast steel lower leg of the strut had been forced and elongated outward from the side of the ship, so that the

Fig. 3.—Thermit Weld on Propeller Strut of United States Destroyer *MacDougal*

propeller shaft bearing was ½ inch out of alinement. To remedy this defect a small section was cut out of the lower leg of the strut, so that it was shortened the required amount. The two sections of the lower leg were then reunited by means of the thermit process. The section welded was 3 inches thick at its thickest part and 22 inches wide, and required 200 pounds of thermit.

Automatic Arc Welder Developed by the General Electric Company

AUTOMATIC arc welding is now accomplished by a new device prefected by the General Electric Company, Schenectady, N. Y., and soon to be put on the market, which is known as the automatic arc welder. This welder, for use with the regular welding set, is designed to take the place of the hand-controlled electrode. It consists of a pair of feed rollers, called feed rolls, driven by a small direct-current motor, which draw in and deliver to the arc a steady supply of wire, and automatically maintain the best working distance. The whole is controlled from a small panel.

The welding head is held by a suitable support with a certain amount of hand-regulated adjustment, and consists of a steel body carrying feed rolls and straightening rolls, which are both adjustable for various sizes of wire. The arm is supported on a gear box, together with the motor. This box contains gears which give three gear ratios, thus extending the range of the device while allowing the motor to operate at its most favorable speed.

The control panel carries an ammeter and voltmeter for the welding circuit, as well as rheostats, a control relay, and the contactors and switches for the feed motor. It is possible to start and stop the equipment from the work

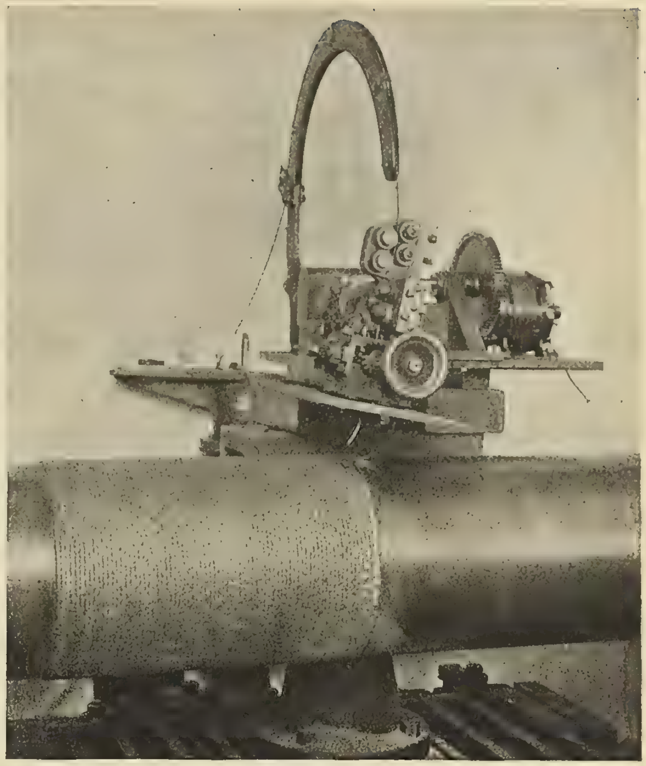

Fig. 1.—The Automatic Arc Welder Building Up 14-Inch Shaft to ⅜-Inch Increase in Diameter. One of Many Functions Which This Device Can Perform

by a pendant push button, but adjustment of the feed conditions must be made from the panel.

The adjustment for arc conditions by regulation of the speed of the feed motor, as the arc voltage varies, is taken care of by the panel equipment. The result is a practically steady arc, which is greatly superior in smoothness of operation to any hand-controlled arc, consequently increasing the speed of the welding.

The whole apparatus is mounted on a base which can be bolted to any form of support. Thus a great variety of working conditions can be met, but provision must be made for carrying the arc at uniform speed along the weld. For instance, for straight seams, a lathe or planer

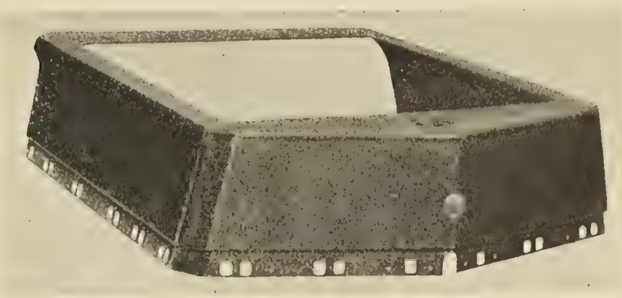

Fig. 2.—Radiator Cover of No. 19-Gage Metal (.044-Inch Thick), Welded With Metallic Electrode by Automatic Arc Welding Process

bed may be used, and for circular ones a lathe or boring mill. However, the local conditions will dictate the method to be followed.

The device is especially valuable where a large amount of routine welding is to be done, since it is capable of from two to six times the speed possible to skilled operators, and gives a uniform weld of improved quality. It is adaptable to welding seams of tanks and plates, rebuilding worn or inaccurately turned shafts (as shown in the illustration), rebuilding worn treads and flanges of wheels, and many other kinds of work.

A New Development in the Application of Electricity to Marine Transportation

Electrical Power Generated On One Vessel Transmitted to Another Vessel for Propulsion and Other Uses—Tests Prove Practicability

BY WILLIAM T. DONNELLY*

IT is almost exactly five years ago that I contributed to this journal (see MARINE ENGINEERING, May and June, 1915) a paper entitled "Application of Electricity to Propulsion," which described the electrically propelled yacht *Dawn,* and gave not only complete and accurate plans of that boat and the electric power generating and propelling machinery, but also foretold the construction and operation of the present vessel the *New Era,* the building and operation of which are described in the following pages:

My comprehension about that time of the familiar sight of one vessel towing another was in reality, from an engineering point of view, much more than we had realized; it was in fact a means of transmitting power from one vessel to another, but with very great limitations. In other words, the power transmission, while complete, was limited to the possibility of moving the vessel towed only in one direction and only in a straight line.

My invention, as outlined five years ago, showed how electric power generated on one vessel and transmitted over a flexible cable could be used not only for propulsion, but for all other purposes. It goes without saying that at that time I believed that the disclosure of this invention and engineering information in connection with it would lead to its development and application, but in spite of the fact that for five years I have used every means of bringing it before all parties who should be interested in such an undertaking, nothing whatever was done so far as I have been able to learn by anyone else to bring into existence the invention outlined and illustrated.

While this may seem to many strange, and to others an indication of the impracticability of the invention, it appears to me as neither of these but only an illustration of the inertia in the progress of human affairs.

Tardy Adoption of New Inventions

A careful research and study in the development of any of our arts will show a similar hesitancy or loss of time between their presentation and the beginning of their adaptation. The original application of mechanical power to marine transportation waited a much longer time; as a matter of fact Robert Fulton spent more than ten years of his life endeavoring to find someone who would become interested with him in the application of steam power for the propulsion of vessels afloat, and in this quest searched Russia, England and France, finally returning to America, where he succeeded in finding one man, Robert Livingston, who would agree to provide half the funds to construct the *Clermont.*

I myself, after waiting five years, have been fortunate enough to be able to finance the undertaking of turning my ideas and inventions as set forth in the paper previously referred to into actual concrete-working form, and the paper herewith presented is for the purpose of recording and presenting the result of the construction and operation of a companion vessel furnished with power and operated from the power plant of the *Dawn* as originally built without modification or addition.

The *New Era,* as the second boat is called, was laid down in the same yard as her predecessor. The name of the builder, however, has been changed from Hehre & Auer to the Dawn Boat and Shipbuilding Corporation, a compliment to the success of the previous boat, and before taking up the description of the *New Era* I should like to record here briefly some facts relative to the intervening history of the *Dawn.*

Service Record of the Dawn

In the summer of 1916 the *Dawn* made a cruise through long Island Sound, visiting New Haven, New London, Fall River and Providence, and many smaller ports, covering a distance of 700 miles, and proved herself to be an ideal home for my family of five; and at each port short trips were enjoyed by my friends.

When in the early part of 1917, it became apparent that the United States must take a serious part in the world war, the use of yachts and motorboats for harbor defense was at once taken up by our Government. The result was that the *Dawn,* under the command of my son, entered the Scout Patrol Service as *S. P.* 26, and served through the summer of 1917 and the winter of 1917-18, patrolling off Newport Harbor.

The *Dawn* was returned to me in the summer of 1918, and I can assure you that she bore marks of the ravages of war, and it was only by the expenditure of a very considerable sum of money that I was able to turn her back into a yacht by the end of that season. I would like to say, however, that the electric power plant stood the struggle in a very remarkable manner, the only replacements or renewals being of small engine parts. It will be understood that the power furnished to the *New Era* from the *Dawn* for the cruise, which I am to describe was by the original power plant as described in the previous paper.

Building the New Era

To return to my description of the *New Era,* the work on this vessel was commenced in the winter of 1918. The lines laid down were the same as those for the *Dawn* with, however, an increased freeboard and a rearrangement of the forward cabin, the increased freeboard forward providing for a flush deck. The power plant, of course, was entirely eliminated. An electric motor for propulsion, of 20 horsepower, the same as on the *Dawn* was placed in identically the same position below the floor of the forward cabin, as will be seen from the illustration. This leaves the entire cabin space of the *New Era* free of all machinery. The pilot house or forward cabin has the usual wheel, and before it the control board.

A Home Afloat

As the *New Era* is primarily built for a home afloat, I will first describe the features which pertain to this part of the undertaking, and as the food supply is the most essential part of a home, we will commence with the galley. The galley is aft on the starboard side, arranged in the same general manner as upon the *Dawn.* An ice

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Fig. 1.—Power Boat *Dawn* Supplying Electric Current for Propulsion of the *New Era*

chest of unusual proportions and fully equal to anything found in a private home is provided and arranged in such a manner that ice can be introduced from the deck outside. Ample provision is made for the storage of eatables both fresh and tinned, also closets for the care of dishes. The water supply is under air pressure, and this feature is exactly the same as in any home. Cooking is done by electric stove, the electric supply coming from an ample storage battery at 110 volts so that standard electric-cooking appliances can be used.

In the cruise which I am to describe, toast was made on the table at every meal, and all coffee was made in an electric coffee percolator.

Living Quarters

The after cabin is approximately 9 feet wide by 12 feet long, and the usual transoms or seats are entirely missing. At the starboard side there is a davenport of ample proportions, which makes during the day a very fine couch, and at night turns into an excellent double-width bed. Forward of this on the starboard side is a closet of ample proportions to hold wraps on coat hangers. Forward, in the center is a combination dresser with bevelled mirrors. Toilet arrangements are provided in two locations aft, and washing facilities in the forward cabin and at two places connected with the after cabin. It will be understood that both fresh and salt water are under pressure, and all plumbing and water fixtures operate exactly as in a house on shore. This is brought about by having round-water tanks and introducing air pressure above the water by an automatic air compressor operated by electricity.

The pilot house or forward cabin is approximately 9 feet by 10 feet, and has across the after end a davenport similar to the one in the after cabin. This is also of

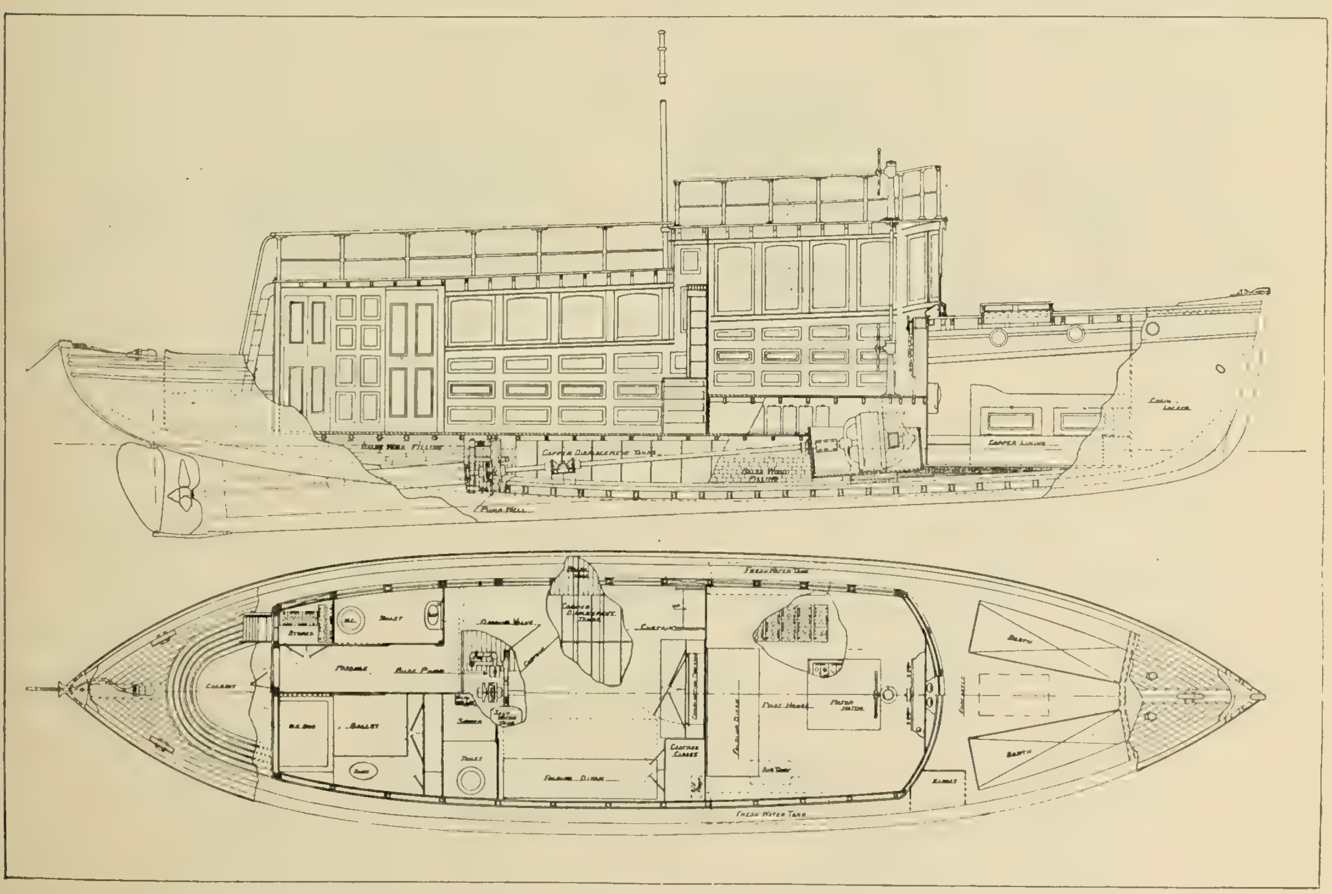


Fig. 2.—General Plans of the *New Era*

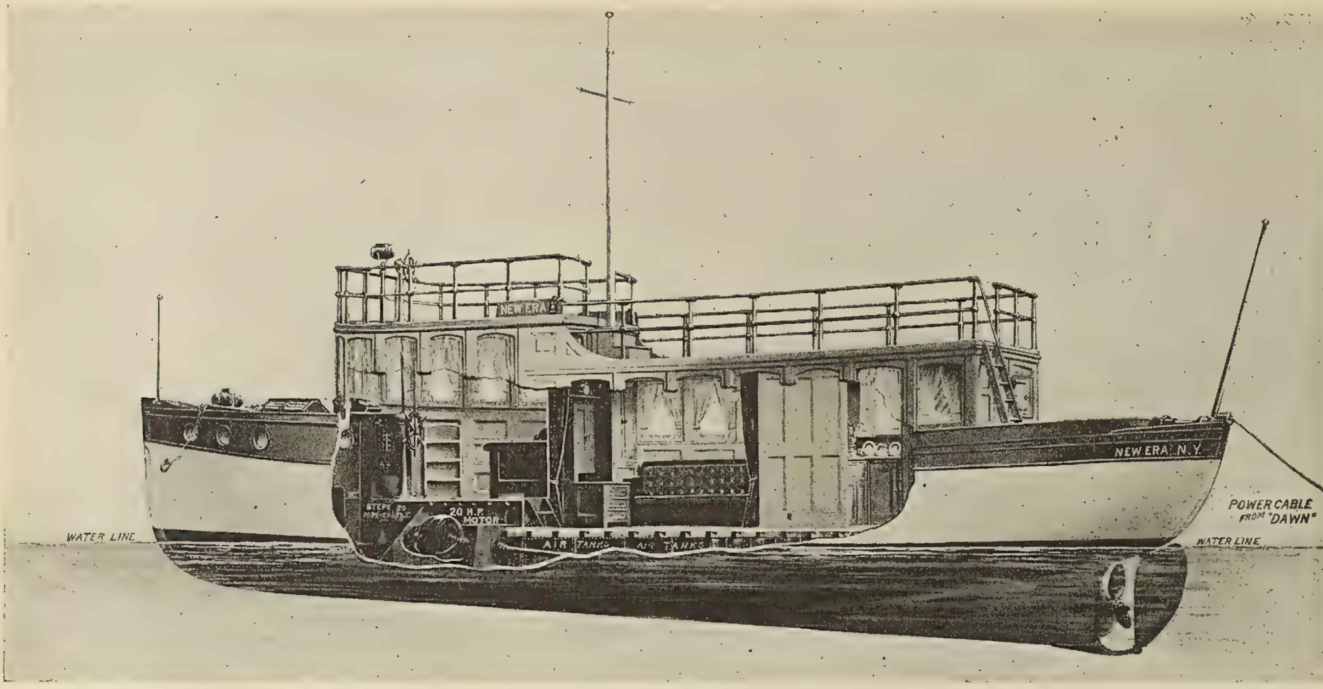


Fig. 3.—*New Era*, the First Vessel to Be Propelled by Electrical Power Generated on a Convoying Vessel

dimensions corresponding to a full-size double bed, in fact both davenports are of standard design intended for use in private homes.

Under the forward deck there are two berths of ordinary ship construction where beds are kept made up. These are fitted in the very best manner with box springs, and all the usual details. Ample locker space is provided throughout.

The lighting is by electric lights supplied with current at 110 volts, by concealed wiring installed according to underwriters' regulations precisely the same as in the best class of private dwellings.

The *Dawn* was built with a flush deck aft, but the *New Era* has a cockpit aft, which makes a more ready access to the cabin and avoids the necessity of cutting the deck.

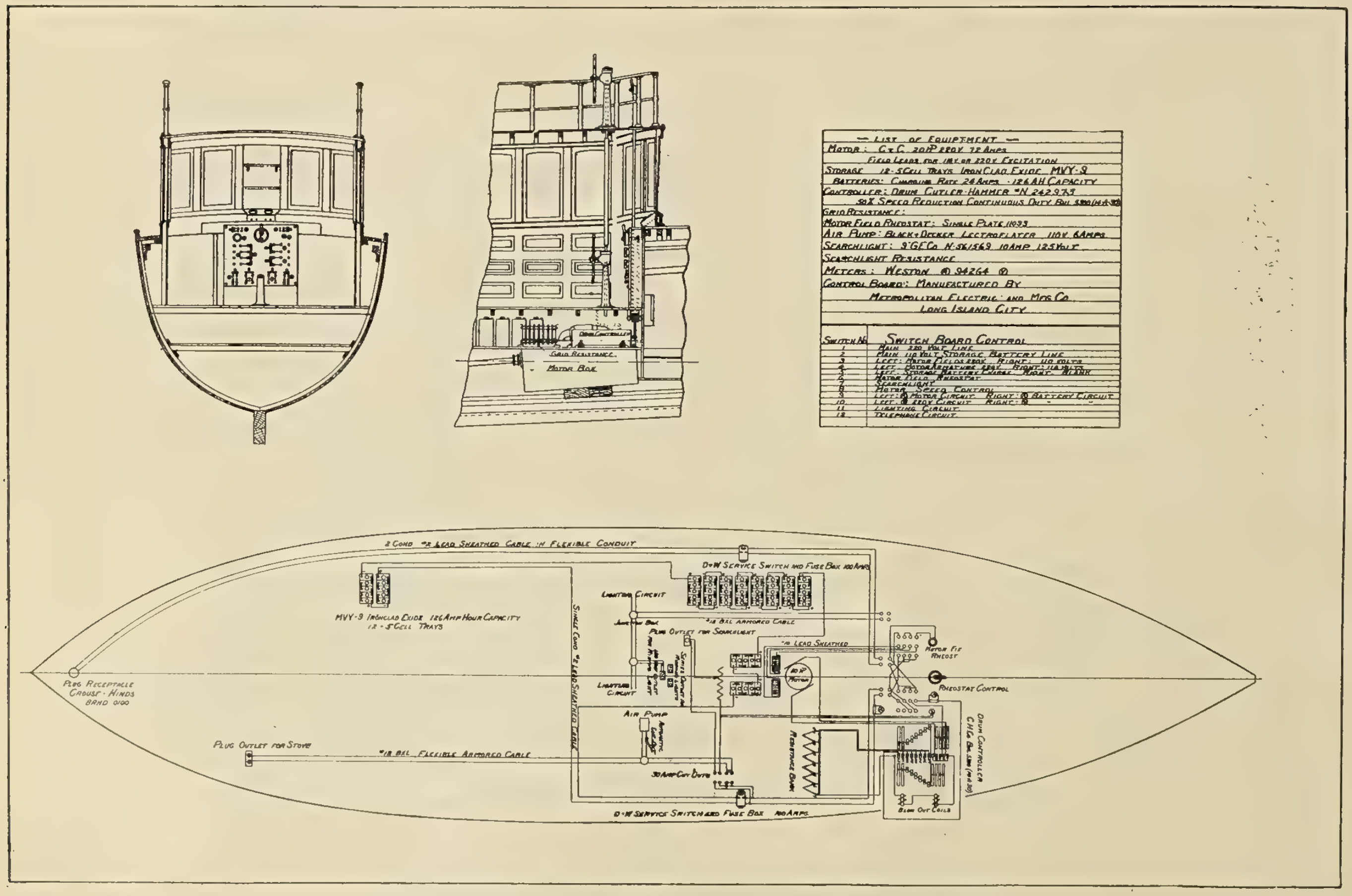


Fig. 4.—Electrical Wiring and Connections on the *New Era*

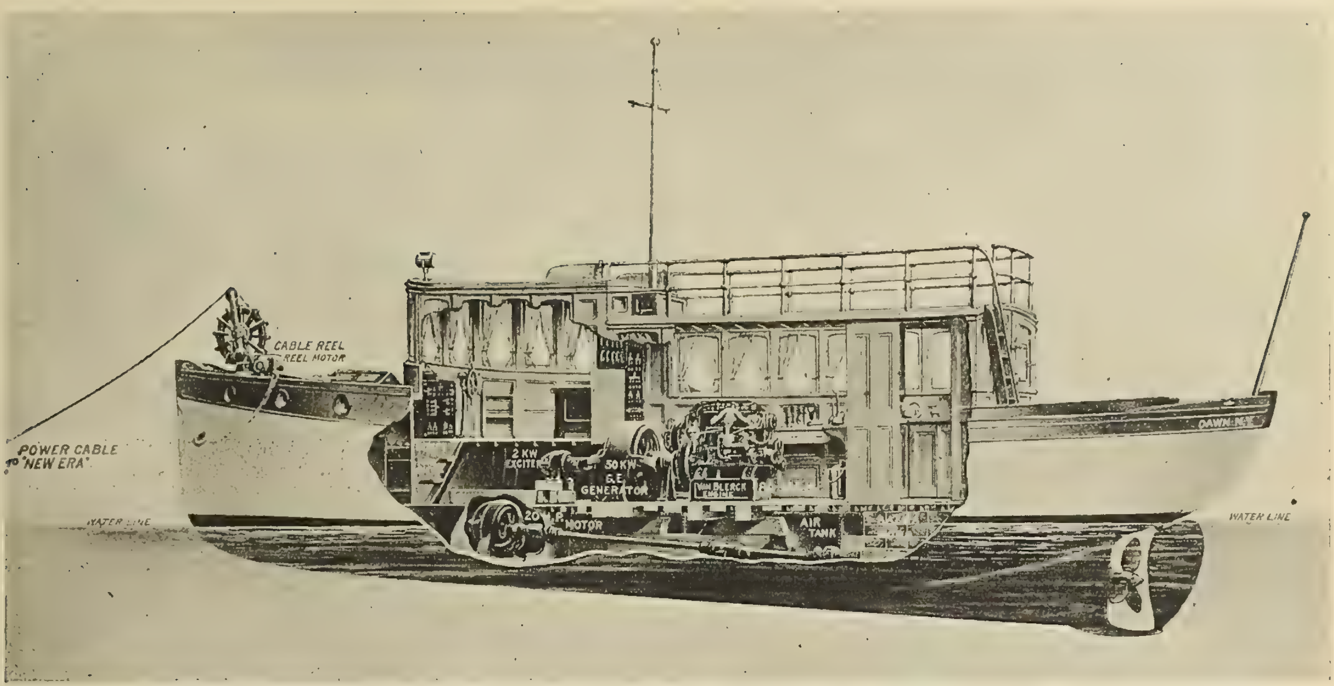


Fig. 5.—Electrical Power Generating Plant and Propelling Machinery on the *Dawn*

NON-SINKABLE CONSTRUCTION

Perhaps the most remarkable feature about the *New Era,* and one which was not contemplated when the previous paper was written is the non-sinkable feature. For many years the non-sinkable and even non-capsizable lifeboat has been well known, but, for reasons which it is hard for the ordinary mind to understand, the development of this feature of floating craft has never been applied to other vessels. So far as I am aware this is the first time that an attempt has been made to render a power yacht of any considerable dimensions entirely safe against sinking. This has been accomplished by placing the floor of the cabin 6 inches above the waterline, and then filling in all vacant space below, first the irregular parts with Balsa wood (a tropical wood lighter than cork), and then the remaining space not occupied by machinery or necessary parts for the boat, by air-tight copper tanks exactly similar to those used in lifeboats.

Of course, in the carrying out of any principle whatever in a physical structure, perfection is never reached, and

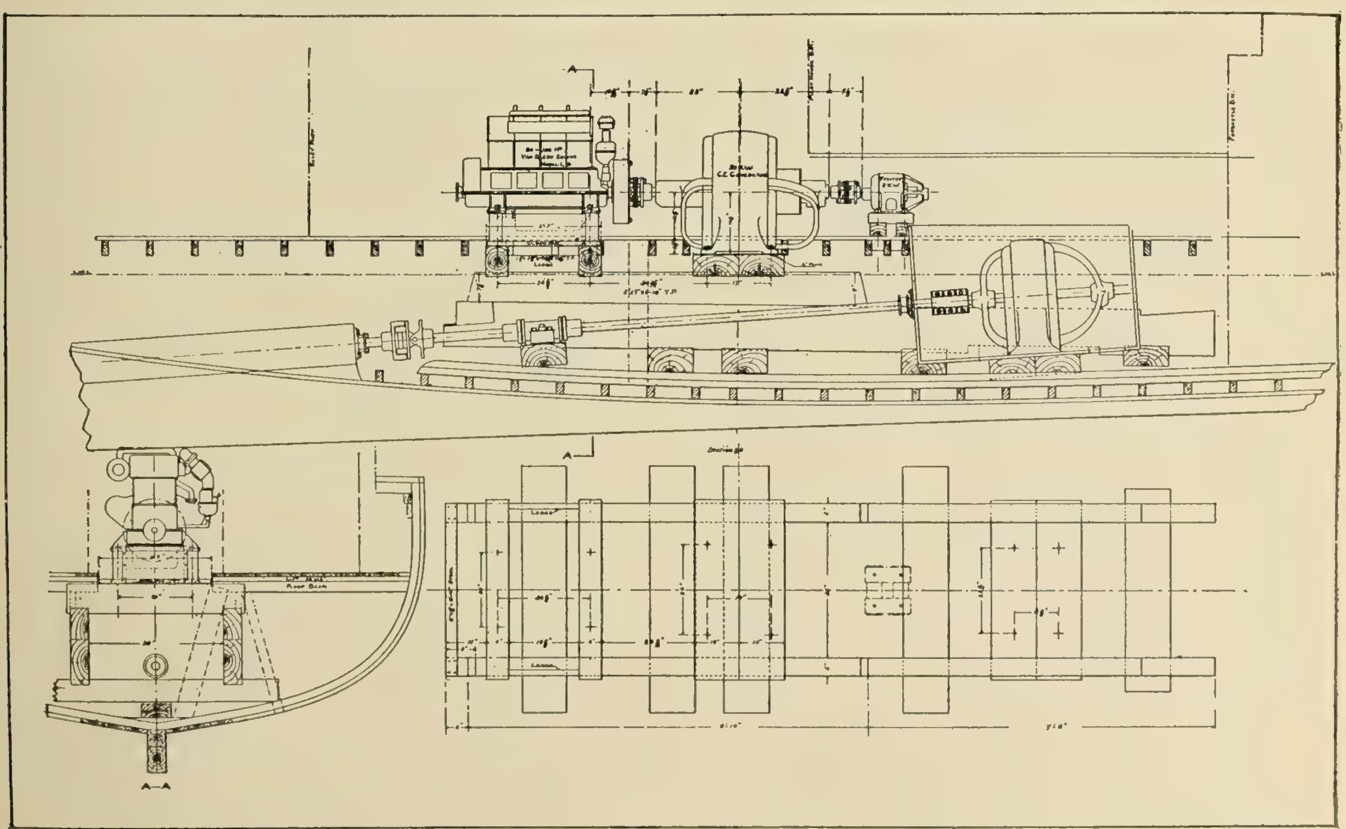


Fig. 6.—Machinery Arrangement of the *Dawn*

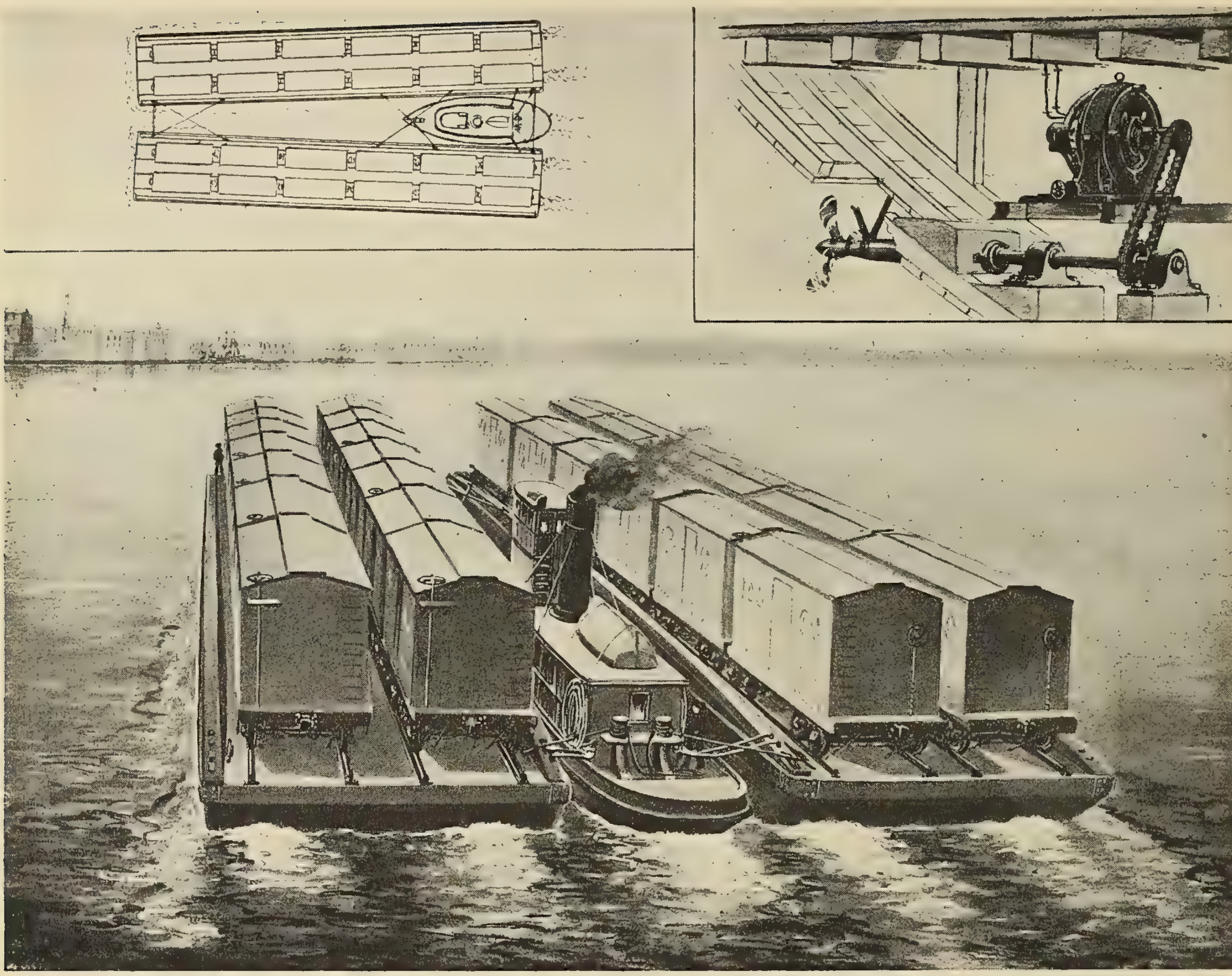


Fig. 7.—Proposed Arrangement for Electrically Propelled Car Floats

it is not possible to occupy every particle of space below the waterline, but it is practical to occupy so much that when water is freely allowed to enter it will be in such a limited quantity that the increased draft of the boat will be a very small amount. In the *New Era* it is actually less than 2 inches, that is, when all leakage is pumped out of the *New Era* and the draft carefully noted and subsequently a hole is opened in the bottom, provision for which is made in the construction of the boat, and water allowed to enter freely, the increased draft of the boat, when the level of water inside and out is the same, is not more than 2 inches. In other words, the boat does not settle far enough for the water to come above the cabin floor, and no fixtures or fittings of the boat are damaged.

The importance of this feature cannot be over-exaggerated. It gives one first, and particularly our ladies whom we like to have with us when yachting, a sense of security which cannot be obtained in any other manner. It gives to us, who put a very considerable amount of money into the building and fitting up of such a floating home, a very great sense of security that we may continue to enjoy our investment for a very considerable period of time.

Cost of the Non-Sinkable Construction

As soon as one is convinced of the possibility of rendering a boat non-sinkable, the mind is crowded with the question, "How much does it cost? Can anyone afford to build a boat that way?"

Having kept a careful record of the cost of rendering the *New Era* non-sinkable, I am prepared to state that it is comparatively such a small amount that the saving in insurance on the value of the boat for one year will approximately recompense the owner for the necessary expenditure. In other words, money so invested pays 100 percent annually on the investment plus all the insurance and satisfaction which come from having a lifeboat under your feet as well as a summer home. The saving in insurance is the difference between the ordinary marine risk, which covers sinking and carries a premium of 5 percent per annum, and insurance against destruction by fire, which is covered by 1 percent.

Electrical Transmission Apparatus

Taking up the engineering or techncal side of the practical application of electricity to marine transportation, the *New Era* is provided with a 20 horsepower motor. The electric current is received from the generating plant of the *Dawn* through a flexible water-proof cable. A reel is provided on the bow of the *Dawn* and the manner of connecting current to the cable will be clearly understood from a study of the plans accompanying the paper.

The separate conductors are led to opposite ends of the axle, or bearing of the reel, and introduced into the hollow axle by suitable plugs. The cable itself is of the well-known concentric construction, that is, an outer and inner conductor separated by insulated material, the outer conductor being again insulated and protected by jute covering. The cable for the transmission of 20 horse-

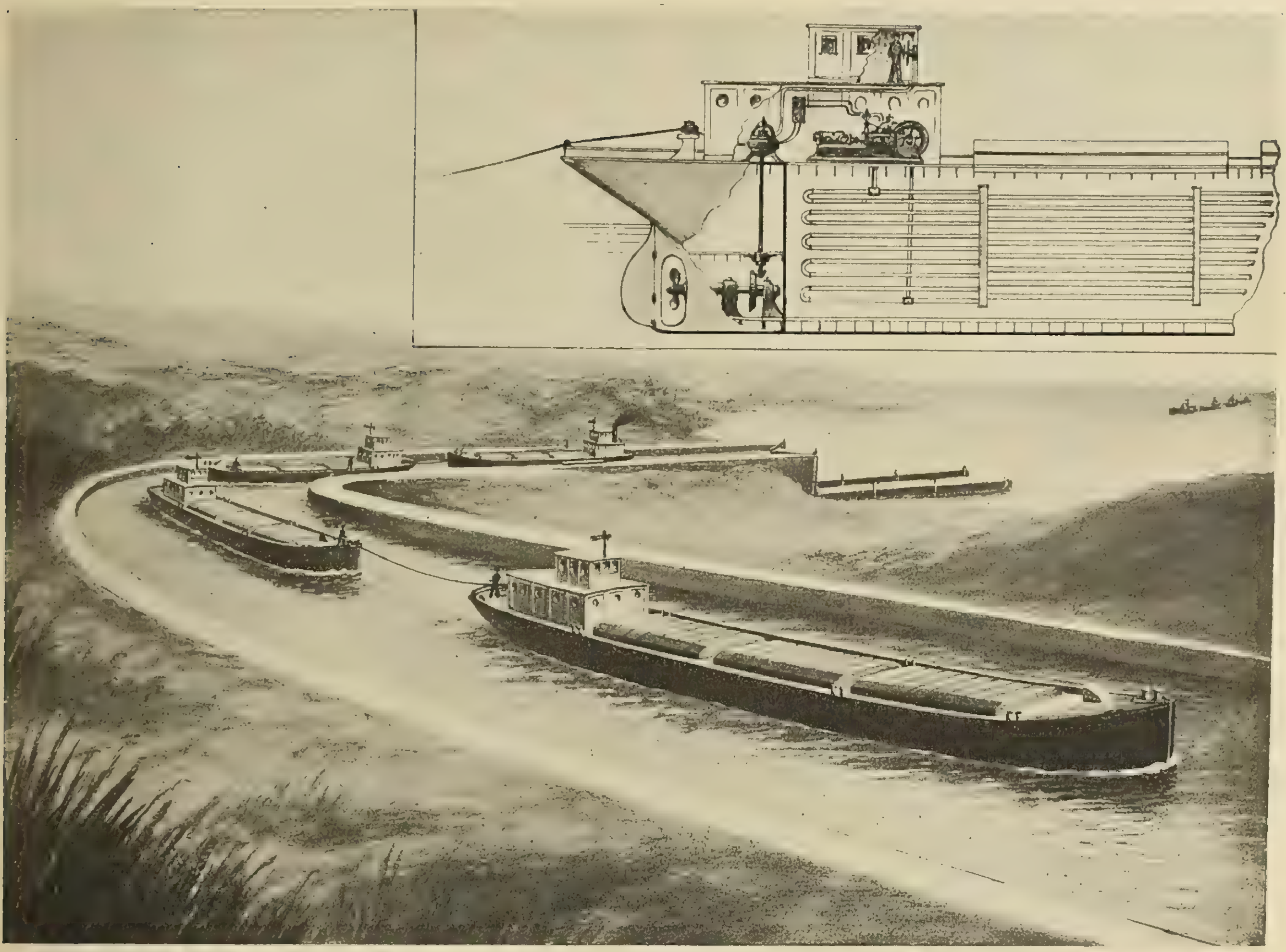


Fig. 3.—Proposed Arrangement of Electrically Propelled and Refrigerated Canal Barges

power at 220 volts is slightly less than 1 inch in diameter, and weighs approximately ½ pound per foot. One hundred feet of this cable was provided, and during the trip to be described about 60 feet of cable was used between the boats, this with the drop or sag of the cable spacing the boats about 50 feet apart.

The cable comes in over the stern of the *New Era* through a special bronze bell-shaped casting. Just inboard from this bell there is attached a line which is led to a convenient cleat for taking the pull due to the weight of the cable. The slack of the cable is then run to an annular plug directly over the rudder post and passes down through the deck, after which the conductors are separated and carried through metal conduit to the switchboard and motor at the forward part of the pilot house. The details of all electrical connections are shown in Fig. 4.

Storage Battery Provided

Besides the connection to the electric motor, provision is made for connecting through proper resistance to an iron-clad storage battery with 60 cells, capable when fully charged of delivering something over 120 volts. The storage battery has a capacity for propelling the boat, when disconnected from the source of power, at a speed of approximately six miles an hour for two and a half hours, it being understood, of course, that in regular cruising all power for the propulsion of the *New Era* is delivered directly from the generator on board the *Dawn* to the motor on board the *New Era,* and in the meantime electricity previously supplied to the storage battery can be used for lighting, heating, cooking or any other purpose.

The 20 horsepower electric motor propelling the boat is operated through a controller introducing resistance into the armature circuit in the usual manner. This controller is placed under the forward cabin floor, as may be seen by referring to Fig. 4, and is of the ordinary rotary type manipulated by engine-room telegraph transmission. The resistance provides five different speeds in either direction.

The mechanical arrangement of the steering and control is such that the boat can be controlled either from the wheel house or directly above on deck.

Propelling Motor Located in Watertight Compartment

Referring to the motor and its location under the floor of the wheel house, it will be apparent that this motor occupies a considerable space below the waterline, and also that water must be excluded from contact with electric parts, such as brushes, etc. To accomplish this, the whole motor is placed within a watertight box made of wood and lined with copper, not on the inside, but on the outside of the box so that the water entering the boat can rise around the outside of this box but cannot come in contact with the motor.

Novel Thrust Bearing

Referring to the transmission shaft from the motor to the propeller, there will be seen a thrust bearing, which it will be understood is of identical construction to the one which was applied to the *Dawn.* This is of very unusual construction, as it is a plain friction bearing and runs entirely without lubrication. The one on the *Dawn* has been running more than five years, and has never been lubricated and does not show any appreciable wear.

Aft of the thrust bearing is a flexible connection of special design, also the same as in use on the *Dawn,* which is very desirable, as it eliminates the necessity of maintaining accurate alinement of such a long transmission shaft. The *New Era* is also supplied with a powerful arc searchlight, which is not only of very real use at night, but a source of very great satisfaction and entertainment during summer evenings.

Besides the electric cable transmitting power, we have a telephone cable connecting the *Dawn* and the *New Era,* and at all times it is entirely practical to communicate with your power plant and crew on the other boat.

Electricity Adds to the Joy of Living Afloat

To speak of the *New Era* as an entirety, I find, is very difficult. To have an electric power generating plant within almost arm's reach supplying electricity in practically unlimited quantity, so far as your necessity is concerned, puts the whole question of life upon the water and its enjoyment upon an entirely new plane. The elimination on the yacht of the power plant, crew, fuel, stores and a thousand and one things which must go with you to make life desirable, let alone enjoyable, far from home and out of contact with all sources of supply, is something almost beyond the dream of man, but here it is accomplished.

Try and comprehend a home combining means of transportation in almost any desired direction, to almost any city, which comprises every convenience that you have known in the matter of light, heat, sleeping, cooking, and all other facilities, also provides employees within arm's reach at your call by telephone at any moment, and at the same time eliminates a thousand and one cares which the ordinary immovable home throws upon you. These and many more which I cannot enumerate await the complete and comprehensive application of electricity to marine transportation.

Materials Used in Construction

While the plans for building the *New Era* were well worked out in advance, those which appertain to making the boat non-sinkable were entirely new, and progress was necessarily slow. Besides this the endeavor was made to spare nothing in the matter of quality of materials and workmanship. The wood entering into the structure was very carefully selected. The frames, keel, stem and stern are of selected white oak, the planking below the waterline of cedar, and above the waterline of Oregon fir in very long lengths. The sheer streak and upper work are of mahogany, the deck and rail of very carefully selected teak wood, the cabin throughout of Mexican mahogany, and the interior panelling work in selected wood and finished in the most careful and thorough manner.

Since yachts have been made, brass or iron railing has been almost exclusively used. To me they have always been a source of annoyance. Brass rail can never be kept polished, and the iron rail always appears to be quarrelling with every other details of the boat. On the *New Era* a departure was made in designing and building the entire rail of mahogany to harmonize with the rest of the boat, and the result has been more than satisfactory. It will be seen that the railing is placed around both the after and forward cabins. The beam of the *New Era* is such as to give more than satisfactory stability with any number of people on the deck of the pilot house. It will be understood that provision is made for awnings in the summer time, although not shown on the plans:

To take up the actual operation of the *Dawn* and *New Era* in convoy, the *New Era* was launched on October 18, 1919, and finally completed on October 31, 1919. The trial trip was from Clason Point to Bayside Yacht Club, Little Neck Bay, Long Island, and proved an entire success.

The Cruise Up the Hudson

On November 3 the boats left Bayside Yacht Club in convoy for a cruise to Schenectady, N. Y. by way of the Hudson River and the New York Barge Canal. The trip down the East River and up through the Harlem River, under and through all the bridges, was made without the slightest difficulty, it being found entirely practical to control the speeds of the two boats, so that the connecting power cable, telephone cable and the light manila line were slack at all times. The first stop was made at Hastings, at 4 p. m., November 3; and the next day the run was made to Ossining and a stop was made for gasoline (petrol). The party on board the *New Era,* consisted of three others besides myself, and on board the *Dawn* were the engineer in charge of the power plant, an electrician and a deck hand.

At Ossining the two boats weathered a severe winter storm, lasting thirty hours, during which the boats were in danger of being driven on a lee shore, but disaster was averted by utilizing the power available from the storage battery. After recovering from this experience, the cruise proceeded northward with delightful weather. A night was spent at Poughkeepsie, and another at Kingston, where the voyage was delayed a day or two on account of thick weather. Leaving Kingston at 12:30 o'clock in the afternoon of November 12, we reached Albany at 7:30 p. m., after dark in a rain storm, separated the two boats below the bridge, took the *New Era* through under her battery power with the aid of the searchlight, and were followed by the *Dawn,* each boat making its own landing at the public pier, where we remained overnight.

The next day we proceeded to Troy and passed through the first lock on the Hudson at that place. This was our first experience with the two boats together entering a lock. We ran in together with two tugboats just ahead, and found not a particle of difficulty, the boats handling as readily and as quickly as the separate tugboat.

Practical Demonstrations

On the morning of November 14, we were joined by four representatives of the General Electric Company who proceeded with us through the flight of locks at Cohoes, which give entrance to the Mohawk River. This flight of six locks, together with the one on the Hudson raised us to an elevation of almost 200 feet above sea level. Lock No. 8 below Schenectady, raised us to a final elevation of 211 feet. Not a particle of difficulty was experienced in maneuvering in and out of any of these locks.

We arrived at Schenectady at 5:18 p. m. Where the *Dawn* and *New Era* were inspected by engineers of the General Electric Company. On November 17, a demonstration trip was made up to and through Lock No. 8, returning to Schenectady.

On the return trip we left Schenectady at 10:30 a. m. November 19, and were down through the last of the locks and into the Hudson at Waterford by 4 p. m. Coming out of the last lock into the Hudson the power plant of the *Dawn* gave trouble by a stripping of the teeth of the rawhide gear driving the exciter from the main generator, and supplying current for separate excitation of the field of the generator and motor of the *Dawn.* This was a definite tieup, but with quick work I was able to leave within two hours with the gears to be turned and re-cut at Schenectady, through the courtesy of the General Electric Company, and we were able to get the

gears finished and returned the next day, after which we proceeded on our way to Albany.

At Albany we tied up at the Albany Yacht Club, and on November 22 made a demonstration run up the river with the superintendent of Public Works of the State of New York, and one of his engineers. The two boats worked perfectly together, turning under full speed and showing perfect freedom of movement, that is, it would be practically impossible to tell that the *Dawn* was being followed by another boat, if one did not turn around to look for it.

Particular attention was called to the fact that the operation of the motor for propelling the *New Era* was perfectly silent and no vibration whatever could be detected. In other words, the *New Era* worked smoothly under perfect control without any apparent means of propulsion.

Leaving Albany on November 23, we made a leisurely trip down the Hudson, returning via spuyten Duyvil and the Harlem River to our winter quarters at Clason Point at 2:15 p. m., November 27.

Improvements for the Dawn

The power plant of the *Dawn* which accomplished this work was gotten together something more than seven years ago. Since then the gasoline (petrol) engine and all things appertaining to it have advanced rapidly, and the accompanying plans of the *Dawn* show the reconstructed power plant which is now being installed, also an auxiliary set of 4-kilowatt capacity, which is to be used for charging storage batteries, lighting, cooking, etc., when at anchor. This set will deliver 4 kilowatts for one hour on the consumption of a little less than a gallon of gasoline (petrol). This means 4,000 watts of electricity for approximately 27 cents. It is generally considered that 600 watts is sufficient to operate an adequate electric-cooking apparatus. Allowing 1,000 for each boat, it is very plain that we will be able to cook on both boats at the same time for an hour for an expenditure of approximately 27 cents for fuel. What more can anyone ask in these times of high cost of living?

This has been rather a full explanation of the practical application of electricity from one boat to another for yachting or recreation sailing, which to me is the sport of all sports, and the nearest thing we know of to an ideal home, not only on the water, but in transit from one city to another.

Broader Application of Electricity to Marine Transportation to Come

The broader application of this method of applying power has now been definitely taken up, and as time goes on I will be able to describe first its application to barge and canal work, and beyond that to passenger vessels, and eventually to all water-borne commerce.

The practicability of this means of distributing and applying electricity has been proved beyond question. There now remains the distribution of the knowledge and the training of others in the art of its use.

The Broady Collapsible Lifeboat

The International Conference on Safety at Sea divided standard lifeboats in two classes—those with rigid sides, called Class I boats, and those with partially collapsible sides, or Class II boats. Both classes were subdivided into three sections and under section *A* of the second class was specified an open lifeboat with the upper part of the sides collapsible; this type calls for buoyant fenders. Sections *B* and *C*, under Class II, cover pontoon boats with a well or flush deck.

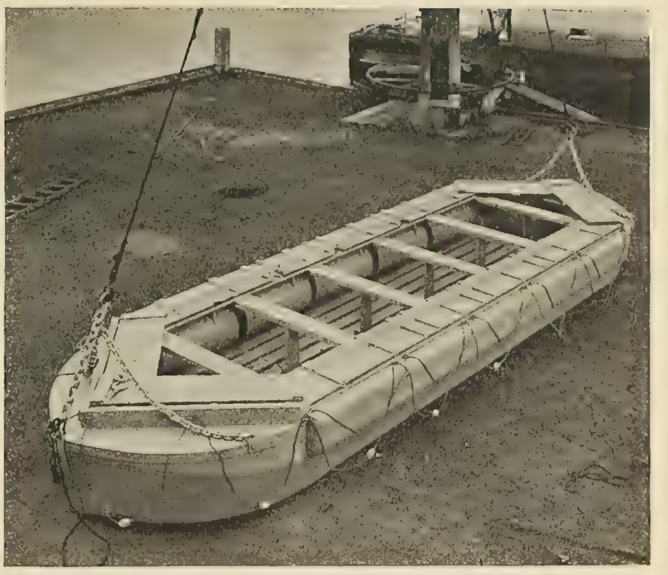


Fig. 1.—Broady Lifeboat with Sides Collapsed

The rulings laid down at the time require that a certain number of lifeboats on board ships must be of the Class I type, while the remainder may be Class II boats, the object of this ruling being to provide boats which could readily be nested under the Class I boats and carried under davits. Accordingly, the design with partly collapsible sides was approved for this purpose, as it is peculiarly adaptable to nesting.

Just before the International Conference was called, the Lundin boat was put on the market. This boat has been fully described in these pages and is familiar to most seafaring men. Although the Lundin boat is of the semi-collapsible type, its performances in actual tests have been such that it is classified as a Class I boat. It is a decked lifeboat with fixed bulwarks above the deck and collapsible sides or weather boards on the bulwarks. Two Lundin boats can be stowed in the same space as one standard rigid boat, but although this was a great step forward there has recently been a growing demand for a lighter, less expensive type of boat, even more compact, to stow under standard or Lundin boats.

The Welin Marine Department of the American Balsa Company, Inc., New York, has developed a Class II boat which might be called a "Lundinized collapsible," for it has some of the most important advantages of the Lundin boats, together with the virtues peculiar to collapsibles, viz., it has the strength and dependability of a first-class

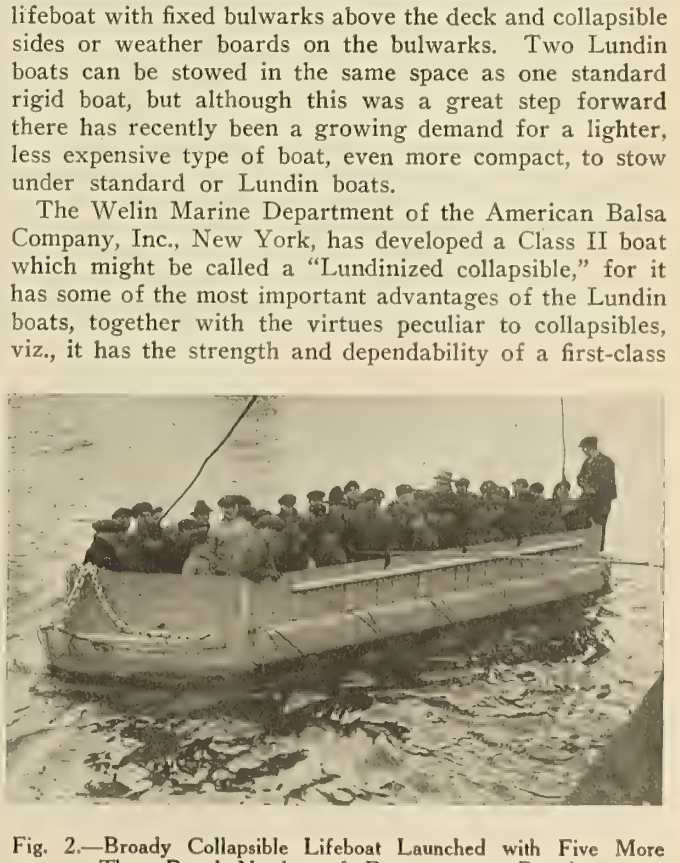


Fig. 2.—Broady Collapsible Lifeboat Launched with Five More Than Rated Number of Passengers on Board

lifeboat and will stow in the small space occupied by a collapsible. This has been called the Broady boat.

The new type of boat is built of steel with an absolutely flat bottom and straight sides, the bottom being reinforced by a network of framing on which the footlings rest. The rigid sides are finished at the top with angle iron carried all around the boat and on this rest the thwarts, as well as a special wooden framework to which the collapsible sections of the sides are hinged. These folding weather-boards are in six parts and so arranged that one man can raise three at a time, and in two operations make the boat ready for occupancy. All sections are secured by self-locking braces. Great reserve buoyancy is secured by Balsa fenders on the outside and galvanized-steel-air tanks inside the boat. Extra heavy fittings are provided and so arranged that the loaded boat, when hanging from the tackles, is exceedingly stable, this being most unusual in boats of such shallow construction.

There was some doubt as to how the boat would stand the test of hanging free in the air when fully loaded, viz., it was feared that there would be undue deflection on account of its flat bottom. At the official tests, however, it was found that, with the boat swung clear and hanging from its own fittings loaded with five more persons than its actual rated capacity, the deflection was only 1/8-inch. In the water the boat was found very steady and gave ample protection to the occupants.

As the Broady type boat carries Balsa fenders, like the original Lundin boat, it is equally well protected against smashing from contact with the sides of the ship.

The 26-foot and 28-foot Broady boats when ready for nesting have a total height of only 2 feet 6 inches, which is exceedingly low, being about 6 inches lower than their prototype, the Lundin boat. All the experience gained in building Lundin and other lifeboats has been put to good use in the construction of this new development in space-saving and life-saving boats.

Ship Repair Facilities on the Gulf

BY CAPT. C. A. MC ALLISTER, U. S. C. G.*

THE rapid increase of our merchant marine has naturally created an insistent demand for repair and docking facilities. Nowhere has this demand been greater than in ports bordering on the Gulf of Mexico. New Orleans, the leading shipping port of the South, is rapidly increasing its foreign trade, and has had the foresight not alone of creating a magnificent dock system, but has vastly increased its ship repairing and dry docking facilities.

The photographs on page 361 well illustrate the progressive spirit in this busy port, as they show a ship built in New Orleans docked in one of the new floating dry docks constructed and operated by a New Orleans firm, The Jahncke Dry Dock & Ship Repair Company. The ship is the non-sinkable French steamship *Gauchy*, built by the Foundation Company for the French Government.

The dock is a new one of the Donnelly type, capable of lifting a 12,000-ton ship. This new dock can be operated in two sections, capable of lifting a 4,000-ton ship and an 8,000-ton ship, respectively. There is also being constructed an 8,000-ton dock of the Crandall type for operation by this firm. This will give three docks to be operated on a splendid section of the waterfront within the city limits, 1,500 feet in length.

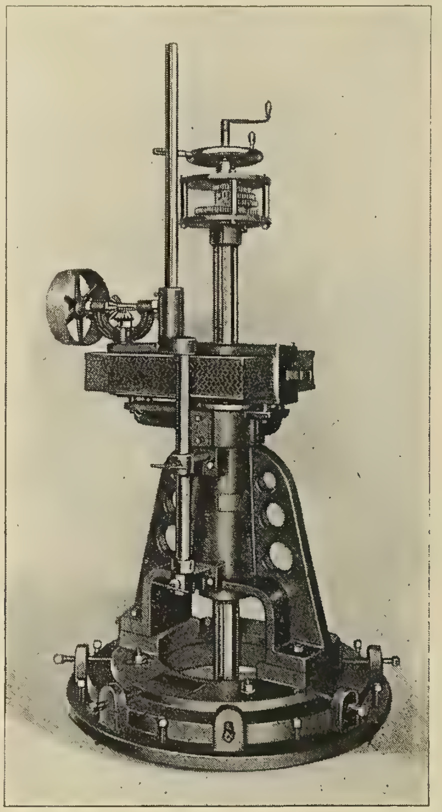
The Jahncke yard, to be operated solely for repair work, is splendidly equipped with a large machine shop, woodworking shop and all necessary facilities for prompt work. A spur from the railroad runs along the entire waterfront of the yard. It has a large power plant, with its own electric generators, air compressors, etc. The pumps for operating the docks are electrically driven, and are capable of lifting the largest vessels within thirty-five minutes.

Heretofore New Orleans has been compelled to utilize the navy yards floating dock for lifting large vessels. As it is estimated that the port of New Orleans, even with these docks, will have about 260 tons of vessels operating from that port for each 1-ton capacity of dry docks, it can readily be seen that this new repair enterprise will probably have to be run at capacity even under normal conditions.

*Vice-president, American Bureau of Shipping, New York.

Rudder Pintle and Deck Boring Machine

TO facilitate the boring of rudder pintles when in position on the vessel, the Pedrick Tool and Machine Company, Philadelphia, Pa., has recently developed the machine illustrated on this page. This obviates the use of a long, unhandy bar as well as the skill, patience and inconvenience attendant upon the setting-up of the bar. Primarily the device is made possible by a patented method of making a portable boring bar travel, thereby providing the means of driving and feeding other boring bars or tools.



Machine Developed for Boring Rudder Pintles in Place on Vessel

As will be observed from the illustration a V-shaped frame which supports the boring bar, feed and driving mechanisms is bolted to a circular plate. A self-contained machine is hereby provided that may be taken to any place where there is work for it to do. Its convenience of operation is further increased by the use of a large circular base plate to which the circular plate of the machine is attached. In the base plate, a number of radial set screws will be seen. These are used to shift

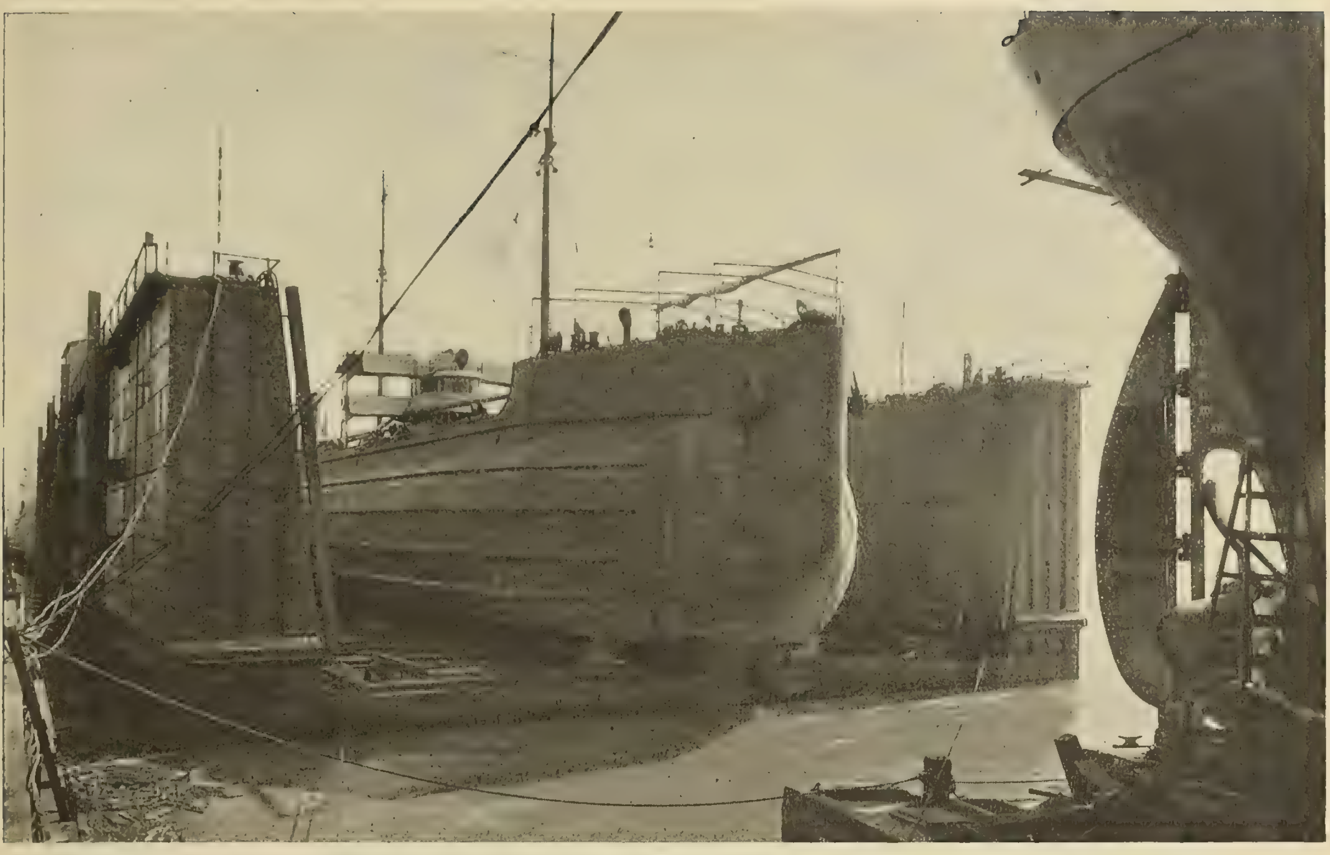


Fig. 1.—New Orleans-Built Ship in New Orleans-Built Dry Dock

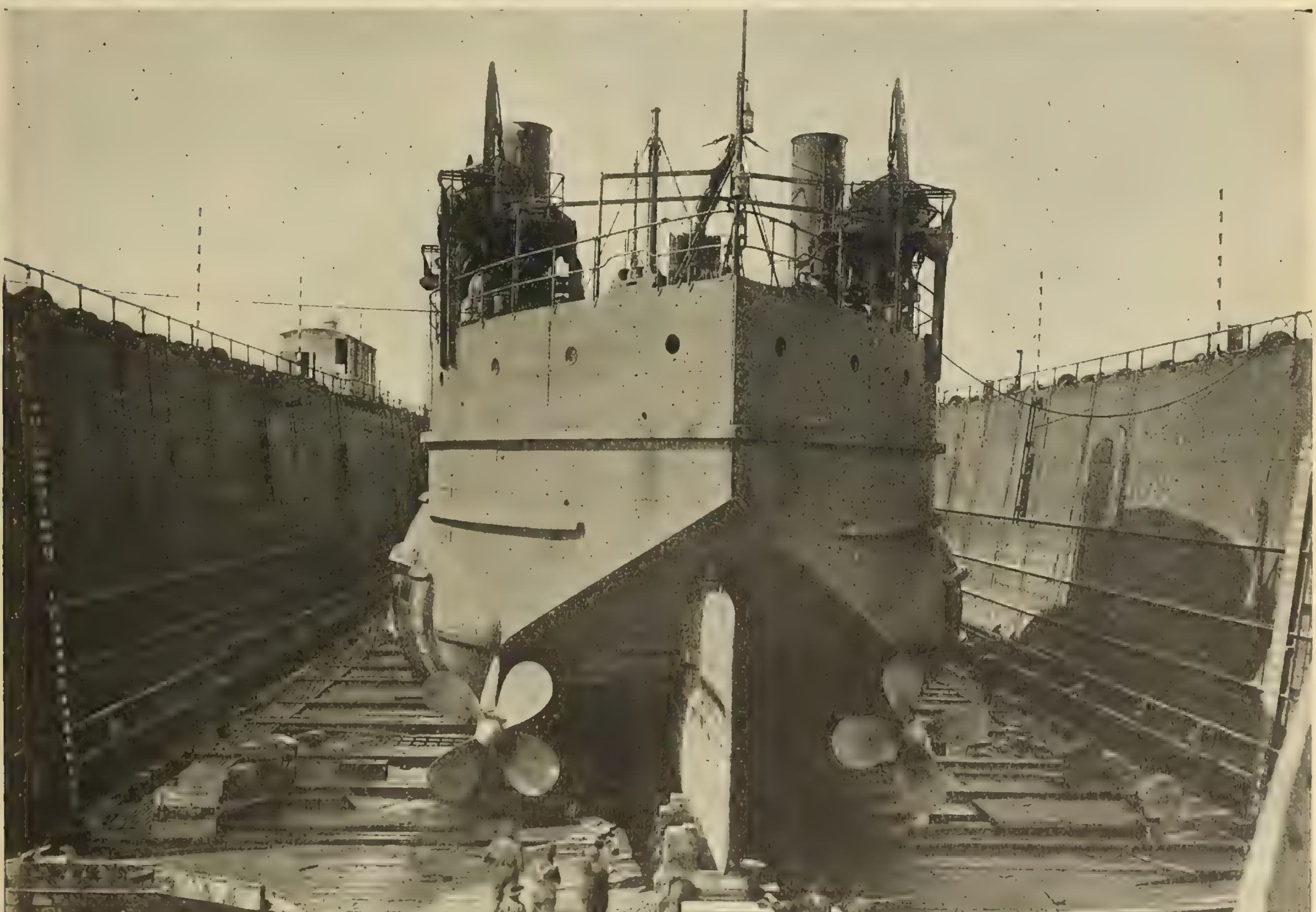


Fig. 2.—French Steamship *Gauchy*, of Non-Sinkable Type Built by Foundation Company, Docked in Donnelly Type Floating Dry Dock at Yard of Jahncke Dry Dock & Ship Repair Company, New Orleans, La.

the machine to its exact location and hold it there after it has been set in approximately the correct position. This adjustment provides for 3 inches of movement out of center in any direction and is an important time-saving feature.

The boring bar in the machine is 4 inches diameter and 8 feet long, giving 48 inches of travel. The feed case on top of the bar provides three changes. It is reversible and is provided with a crank handle for obtaining quicker movement of the bar in raising or lowering it. When the handwheel revolves with the bar the feed is not operating, but by keeping the wheel from turning the feed becomes automatic. The upright shaft shown in the illustration is the means of holding the handwheel stationary and controlling it from a convenient position. The end of the bar is bored for a No. 6 Morse taper in which other sizes of bars can be inserted.

A very desirable way to equip the machine, it is claimed, is by having sectional auxiliary bars 4 inches diameter, 5 feet long with a No. 6 Morse taper on one end and the same size socket in the other. The sections as needed are put together and secured by taper pins.

If an opening in the deck is wanted, the machine can be placed in position and a hole started in the solid plates until drilled and bored large enough to permit a through bar to be attached. Cutters may be spaced on the auxiliary bars at proper intervals so that several holes may be bored at one time, as the driving gearing is of ample power for such work.

Arrangement for belt drive is shown in the illustration but air or electric motors may be connected whenever these methods are desired.

Standardizing Tackle Blocks*

FOR some time, naval architects, engineers and draftsmen, as well as the owners and operators of various types of ships, have recognized the fact that there has been a sad lack of data in regard to the tackle blocks used in their rigging equipments. This has been especially true of the malleable iron shell and steel shell blocks used for heavy loads.

It is true that tackle-block manufacturers have had certain standards of construction, and that it has been possible in some cases to secure from them dimensions of various parts and fittings. How these dimensions were arrived at, however, could not be determined, and it has been only through the wasteful process of repeated failure in actual service that tackle-block users have determined what sizes and types of blocks might be used for specific purposes.

Because of these conditions, the Emergency Fleet Corporation was placed at a great disadvantage during the war. Efforts were made to obtain adequate data from the block manufacturers, but because of their inability to secure the complete information required it was necessary for their draftsmen to do the best they could with the material available. The extreme wastefulness of this method has been amply proven in the breaking and binding of the specification blocks when the ships were loading, and in the heartbreaking delays, due to the necessity of securing blocks for replacement.

This state of affairs is known to all shipbuilders, and has often been deplored. To a lesser extent they, too, have had to learn by bitter experience, and the standards arrived at in their specifications are based almost entirely on observation and a knowledge of working conditions.

*Data supplied by the Engineering Department of the Parish Supply and Manufacturing Company, Chicago, Ill.

An effort has been made by block manufacturers to remedy this lack of information, and tackle block users may now secure scientifically determined data in regard to every detail and specification. Engineers have completed numerous experiments and tests, which have proved that in the design of a tackle block the stresses in various parts of the block, resulting from the load carried, may be determined with a considerable degree of accuracy. This information may be used in properly designing the various parts.

Typical Calculations for Tackle Block Design

As a typical example of the methods employed, a triple, heavy-pattern, diamond-shell block, Fig. 1 may be taken.

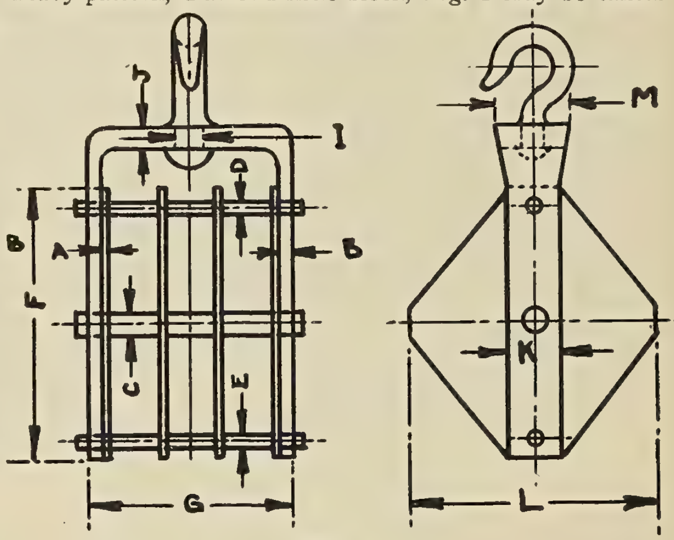


Fig. 1

This block has 12-inch sheaves designed to carry a load of 7 tons. The hook for the hoist is a number 13 Williams-Vulcan hook with a shank diameter of 1¾ inches.

The strap is shown in Fig. 2. The center pin has a diameter of $d = 1\frac{1}{2}$ inches. The important factor in the design of the pin is the bearing pressure of the bronze bushings in the hubs of the sheaves, per square inch of projected area. This is

$$p = \frac{Q}{Z' \times d} = \frac{14{,}000}{4\frac{7}{8} \times 1\frac{1}{2}} = 7{,}920 \text{ pounds per square inch,}$$

where: Q = total load on block,
Z' = combined length of hubs of sheaves,
d = diameter of pin.

The resultant pressure is comparatively low because the more or less intermittent use of a tackle block permits much higher pressures, especially in the case of a high-grade bronze block. The pin may then be checked for bending stresses, considering it as a beam supported at both ends and carrying a uniformly distributed load of 14,000 pounds. However, the pin receives considerable support from the cheek plates between the sheaves, which reduce the resultant stresses very considerably; the amount of this reduction it is, however, impossible to calculate with any degree of accuracy.

The sides of the strap are in tension, the weakest section being at the center pin. This section is shown in Fig. 3. The load is $Q/2$, so that we have the equation

$$\frac{Q}{2} = (a - d)\, b\, S_t,$$

in which S_t is the safe tensile stress of the material. A factor of safety of 4 or 5 may be used, which will give a

value of 12,000 to 16,000 for mild steel. We can now assume a value for either a or b and calculate the other dimension. Taking b at 5/8 inch, and S_t at 12,000, the equation becomes;

$$\frac{14{,}000}{2} = (a - 1\tfrac{1}{2}) \times \tfrac{5}{8} \times 12{,}000.$$

Solving this for a, the result is $a = 2.44$ inches, which for reasons of construction is increased to 3 inches.

The crown of the strap is treated as a beam supported at the center and carrying a load, $Q/2$, at each end. The

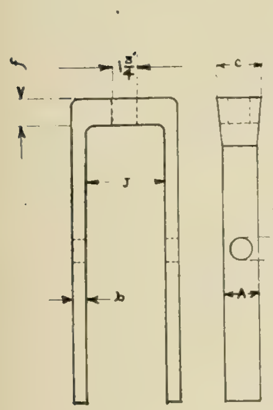


Fig. 2

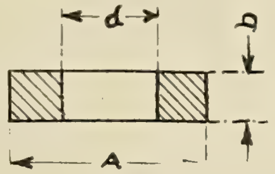


Fig. 3

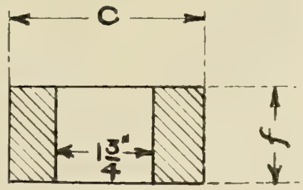


Fig. 4

dangerous section, Fig. 4, is at the center. The bending moment at this section is;

$$M = \frac{QZ}{4}.$$

We therefore have the equation;

$$\frac{QZ}{4} = S_b\, Z,$$

in which S_b is the safe bending stress and Z is the section modulus, which for this section is $1/6\ (c - 1\tfrac{3}{4})\ f^2$ The equation thus becomes

$$\frac{QZ}{4} = 1/6\ (c - 1\tfrac{3}{4}) \quad S_b.$$

A value of c is now assumed, say 4 inches, and S_b is taken at 16,000. Solving the equation for f the result is

$$\frac{14{,}000 \times 7}{4} = 1/6\ (4 - 1\tfrac{3}{4})\ f^2 \times 16{,}000.$$

$$\text{and } f = \sqrt{\frac{6 \times 14{,}000 \times 7}{4\ (4 - 1\tfrac{3}{4}) \times 16{,}000}} = 2 \text{ inches.}$$

Determining the Stresses in Wire Rope

It may be well to calculate the stress in the wire rope which is 3/4-inch diameter, the usual 6 strand, 19 wire per strand hoisting rope. A very important factor, frequently neglected, is the stress produced in wire rope due to its being bent over a sheave of comparatively small diameter. This stress must be added to the tensile stress produced by the load carried.

According to Bach the stress due to bending a wire rope over a sheave is

$$S_b = \tfrac{3}{8}\, E\, \frac{h}{D},$$

in which E is the modulus of elasticity (30,000,000 for steel), h is the diameter of the individual wires of the rope, and D is the sheave diameter. For a pair of triple blocks, each rope will carry 1/6 of the total load of 2,400 pounds. The diameter of the wire is approximately 1/15 of the rope diameter, or 0.05 inch. Then

$$S_b = \tfrac{3}{8} \times 30{,}000{,}000 \times \frac{.05}{12} = 47{,}000 \text{ pounds per square inch.}$$

The stress due to the load S_t is

$$S_t = \frac{Q}{nA},$$

where A is the sectional area of each wire, and n is the number of wires in the rope, so that

$$S_t = \frac{2{,}400}{119 \times 0.00196} = 10{,}300 \text{ pounds per square inch.}$$

The total stress is

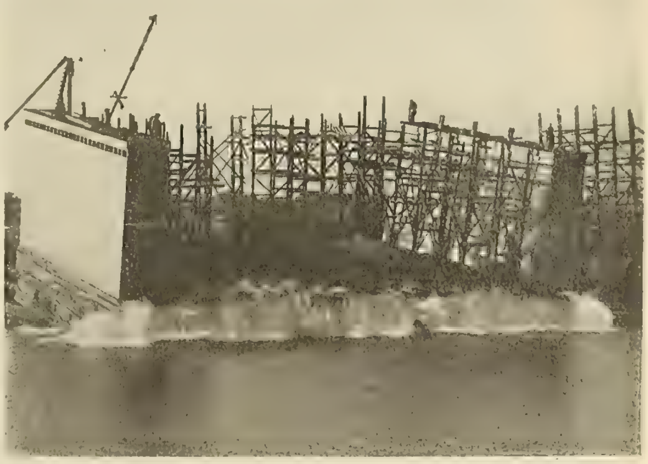
$$S = S_b + S_t = 57{,}300 \text{ pounds per square inch.}$$

It is thus seen that the bending stress in this case is by far the most important. For high-grade plow steel rope the factor of safety is about 3, which is not too low for such material.

Each size block may be treated in the same manner and calculations carried through, by the use of the same formulas. Such data in handbook form have been compiled by the Parish Supply and Manufacturing Company, for the use of naval architects, engineers, rigging draftsmen and others who are interested in the application of scientific methods to the production of tackle blocks. Such books will be supplied by this company on request.

New Crandall Floating Dry Dock

The third pontoon of the floating dock being built for the Bruce Dry Dock Company, Pensacola, Florida, was successfully launched on February 7. Indicators on the pontoon showed no measurable deflection during the



Launching of Pontoon for Floating Dry Dock at Pensacola

launching. It is believed that the construction of this pontoon establishes a world's record, it being built and launched in 39 days and 6 hours from the time of laying the first timber. The floating dock is being constructed by the Aberthaw Construction Company under the supervision of Paul H. MacNeil, resident engineer of The Crandall Engineering Company, drydock engineers, East Boston, Mass.

Developments in High Vacuum Apparatus*

BY G. L. E. KOTHNY

Steam turbines require the highest possible vacuum for highest efficiency and economy. The importance of this has been realized, and considerable research work has been carried out and many developments have been made in relation to the condensation of steam and the extraction of air. It is intended in the following to record some developments which have been made during the last few years in the extraction of air from marine condensers.

THE recognized limits of vacuum for well-designed marine turbine surface condensers based upon the inlet temperature of the circulating water are as follows:

1½ inches Hg. absolute with sea water at 60 degrees F.
2 inches Hg. absolute with sea water at 70 degrees F.
2.4 inches Hg. absolute with sea water at 80 degrees F.
2.75 inches Hg. absolute with sea water at 85 degrees F.

When estimating the correct size of air pump to use, the chief factor to bear in mind is the normal air leakage which the pump must handle. No definite rule can be laid down for the amount of air leakage, as it depends on the size and character of the installation. In small installations this is relatively higher than in large ones.

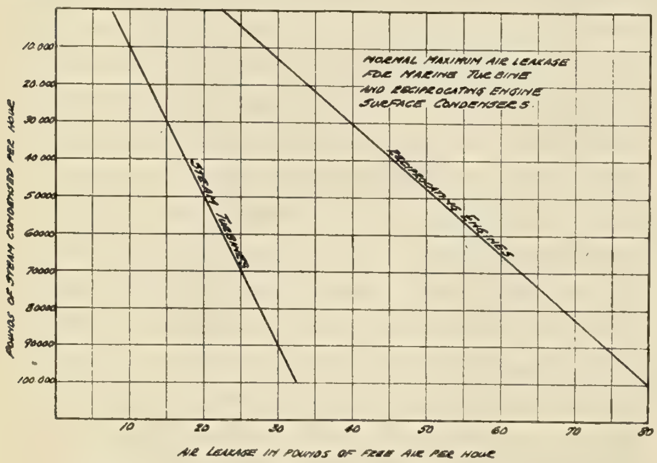


Fig. 1.—Normal Air Leakage for Marine Condensers

Also in condenser installations where a large number of auxiliaries, particularly those located on deck, are exhausted into the main condenser, the air leakage is greater than in a normal installation, and a larger air pump will be required.

Extensive investigations have shown that the normal air leakage for marine surface condenser installations can be limited to the amount shown in Fig. 1, provided that any auxiliaries exhausting into the main condenser do so at a pressure slightly above atmosphere. The curve illustrated in Fig. 1 is based on the total amount of steam which the condenser receives. It also includes the air contained in the exhaust steam. The air received from the condenser is always fully saturated with vapor, the amount of which depends upon the temperature and absolute pressure. The relations between water vapor and air at different absolute pressures and temperatures based on Dalton's Law are illustrated in Fig. 2. In determining the air-handling capacity of the pump, the amount of vapor should be deducted from these curves and added to the normal air leakage given in Fig. 1.

In looking over Fig. 2 it will be seen that at a constant absolute pressure the amount of vapor decreases with the drop in temperature. It is therefore desirable to remove the mixture at the lowest possible temperature in order to decrease the size of air pump. This fact has been recognized, and has led to the adoption of the dry system in which the air and the condensate are removed separately.

The dry system permits the removal of the air and vapors at the lowest possible temperature by a dry air pump; the condensate is taken away at a higher temperature by either a turbine-driven or reciprocating condensate pump. Since the adoption of the dry system, many developments have been made in dry air pumps, the most notable being the steam air ejector, which, due to its many

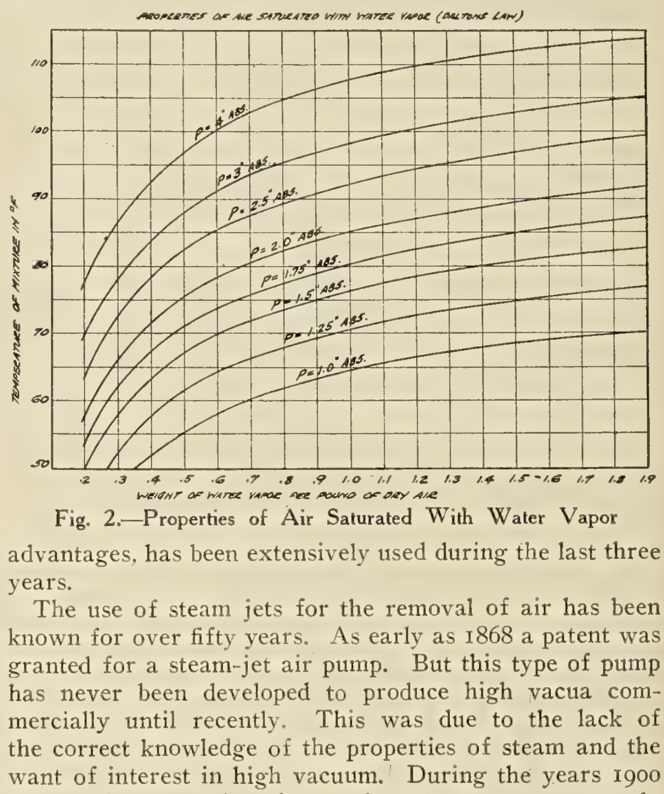


Fig. 2.—Properties of Air Saturated With Water Vapor

advantages, has been extensively used during the last three years.

The use of steam jets for the removal of air has been known for over fifty years. As early as 1868 a patent was granted for a steam-jet air pump. But this type of pump has never been developed to produce high vacua commercially until recently. This was due to the lack of the correct knowledge of the properties of steam and the want of interest in high vacuum. During the years 1900 to 1910 the properties of steam have been more accurately determined by several prominent scientists who made it possible to carry out experiments for the improvement of steam air ejectors. At the same time the demand for high vacuum became more pronounced, due to the adoption of the steam turbine.

The steam air ejector is a compressor in which the air to be compressed is entrained by one or more steam jets, which move through the entrainment space at a very high velocity. The entrainment is made by friction. The kinetic energy, originating from the steam jets, and contained in the mixture of air and steam after entrainment, is transformed into pressure in a channel called the diffuser.

Referring to Fig. 3, air enters through opening A into the entrainment chamber E; live steam expands through

*From a paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1919.

one or more nozzles whereby its static energy, due to its pressure, is transformed into kinetic energy. This transformation causes the steam to leave the nozzle with a velocity ranging from 3,000 to 4,000 feet per second. The steam jets *J*, while passing through the entrainment chamber *E*, entrain the air and give up part of their kinetic energy to the same. The outlets of the nozzle or nozzles are arranged opposite the opening of the diffuser, and the mixture of steam and air enters the diffuser at a somewhat lower velocity than that of the steam jets leaving the nozzles. The mixture is gradually brought practically to a rest in the diffuser *D*, thus increasing its static pressure to or slightly above atmosphere.

The efficiency of a steam air ejector depends upon the magnitudes of three losses:

(a) The friction losses in the expansion nozzle.
(b) The impact losses during entrainment.
(c) The losses in the diffuser.

Due to the development of steam turbines the nozzle design has approached nearly the highest degree of efficiency possible, and the friction losses in a well-designed steam nozzle are seldom more than 10 percent (see H. Frederic and Kemble, Transactions of the American Society of Mechanical Engineers, 1909). These losses depend mostly on the length of the nozzle and the condition of the inner surface.

The loss due to impact is influenced by the relation that the momentum of the steam, plus the momentum of the air before the impact, must equal the momentum of the co-mingled steam and air after impact. If we designate the amount of live steam to be G_1 pounds, the amount of air entrained G_2 pounds, the velocity of the live steam at the outlet of the nozzles V_1, the velocity of the air V_2, and the velocity of the mixture V_3, we can write the following equation:

$$G_1 \times V_1 + G_2 \times V_2 = V_3 \times (G_1 + G_2).$$

The impact loss can be minimized by letting the air acquire a higher velocity before combining with the steam jets. This, however, would make it necessary to produce a smaller absolute pressure in the entrainment space and to provide an annular air nozzle ahead of the same. As a result the pressure rise in the diffuser would have to be greater than otherwise, and consequently the loss in the diffuser will be increased. Careful experiments and calculations have shown a certain range of conditions within which the sum of all the losses is a minimum. The under-expansion and arrangement of an air nozzle prior to the entrainment has been found to be of advantage only for very small compression ratios, which, however, are not used in steam air ejectors producing high vacuum.

The losses in the diffuser are considerably larger than those in the nozzle. They range from 25 to 50 percent and are influenced by the length and the shape of the diffuser, as well as by the conditions of the inner surface.

The ratio of compression is the ratio between the absolute pressure of the air at the air intake and that at the air discharge. Since turbine condensers require vacua of 2-inch Hg. absolute or less, the ratio of compression has to be 1 to 15 or more. While it is possible to obtain such a high compression ratio in a single stage, carefully made experiments have shown the inadvisability of using such a high compression ratio single-stage ejector for practical purposes. The following conclusion will illustrate why:

Assumed that a single-stage air ejector is designed to produce a vacuum of 2-inch Hg. absolute. When starting this ejector, the absolute pressure at the air intake is the same as that at the air discharge, namely, atmospheric pressure. The steam will leave the nozzle with considerably less velocity than that which it would obtain under normal operation. The efficiency of the nozzle will be decreased, and the entrainment surface (outer surface of the steam jet) will be decreased. The air to be entrained is in a less rarefied state, hence the loss due to the impact during entrainment is also greater. Consequently the velocity of the mixture is smaller and its volume is larger. As this mixture has to pass through the throat of the diffuser, the sectional area of the diffuser would have to be enlarged for starting conditions. If this is not done, starting will become impossible. Assumed that the steam jet after leaving the nozzle does not touch the diffuser walls, but leaves an annular opening or channel between the outer surface of the steam jet and the inner walls of the diffuser through which the air is entrained (as shown in Fig. 4), a vacuum will be produced which will gradually increase with the decrease of the losses. The velocity of the steam will increase with the

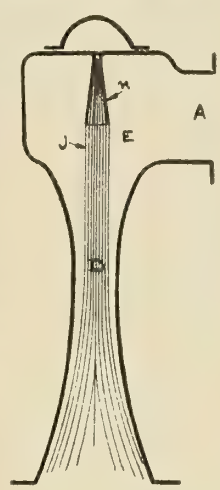


Fig. 3

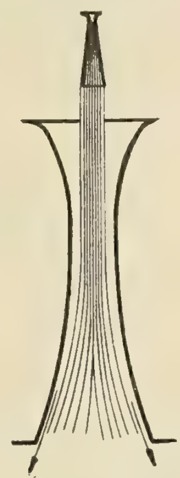


Fig. 4

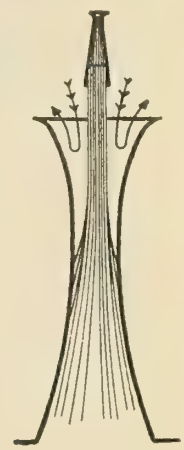


Fig. 5

vacuum. This in turn will retard the enlargement of the diameter of the steam jet. The increasing difference of pressure in the diffuser will recede farther towards the diffuser throat. And if the designed vacuum is obtained before the steam jet touches the diffuser wall, the ejector will start spontaneously.

If, however, the jet touches the diffuser walls before the designed vacuum is obtained, the entrained air cannot pass. It will re-circulate, as illustrated by the arrows in Fig. 5, and the ejector will never start. This will happen if a single-stage ejector is designed for 2-inch Hg., because its diffuser throat area will be entirely too small for starting conditions. If increased in sectional area to overcome those, the section will be too large to be filled out with the co-mingled steam and air at 2-inch absolute, and atmospheric air will rush back into the entrainment space and the desired vacuum will not be obtained.

To overcome this difficulty such a single-stage high-compression ratio ejector would have to be provided with either a flexible diffuser or special arrangements for starting.

In all ejector designs, whether for low or high compression ratio, the above facts have to be given careful consideration. The diffuser throat is generally enlarged over the required size for design conditions. This enlargement represents a compromise between diffuser losses and the self-starting capacity. The latter is more important than high efficiency. In practical installations vacuum conditions vary, and lack of this self-starting characteristic will cause the ejector to stop working, which may have serious consequences. Experiments have shown

that the maximum ratio of compression for a single-stage ejector working in connection with condensers should not exceed 1 to 7. In other words, when it is desired to have more than 25½-inch vacuum with 30-inch barometer, it is advisable to arrange two ejectors working in series and divide the ratio of compression. All high-vacuum ejectors used with marine turbine condensers consist of two stages—the first stage, which is connected to the air suction of the condenser and which exhausts into the second stage at a pressure varying from 4 to 10-inch Hg. absolute; the second stage, which compresses the mixture of steam, air and vapor received from the first stage to a pressure slightly above atmosphere. The steam used in both stages, while passing through the ejector, gives up its energy but does not lose its heat, with the exception of some small losses due to radiation. The exhaust from the ejector is discharged into the feed tank. The heat in the steam is by this means transmitted directly to the boiler feed with practically no loss.

The characteristic of the performance of the steam-air ejector is illustrated in Fig. 6. Curve *A* shows the air-handling capacity of a two-stage ejector designed for 2 inches absolute at different absolute pressure when exhausting dry air and when being supplied with a constant quantity of dry saturated steam of constant pressure, and when exhausting against a constant back pressure of ½-pound gage. It will be noted that the air ejector is capable of producing an absolute pressure of 0.25-inch Hg. at dead end (with the air suction blanked off). The capacity increases steadily with the increase of absolute pressure.

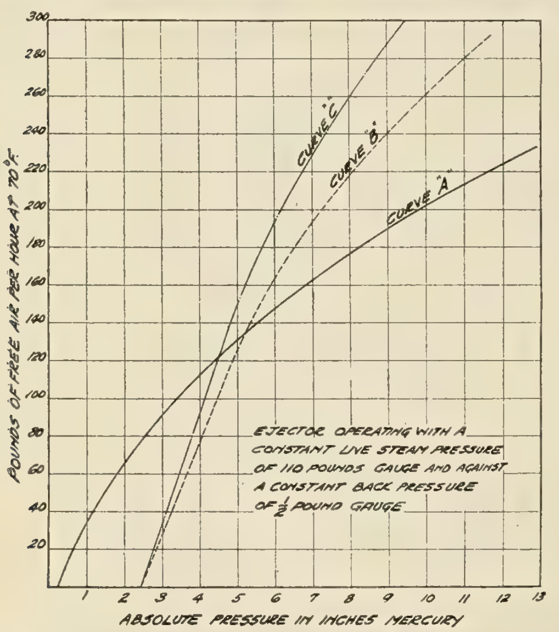


Fig. 6.—Characteristics of Performance of Steam-Air Ejector

The actual dry-air handling capacity of the second stage of the same ejector working under similar conditions is illustrated in curve *B*. The steam consumption of the second stage is, of course, less than the total steam consumption of the two stages.

Curve *C*, shown in dot-and-dash lines, represents the air-handling capacity of the second stage based on the total steam consumption of the two-stage ejector.

Comparing these curves it will be noted that at 5 inches Hg. absolute the second stage alone handles as much air as both stages together, and that from this point the capacity of the second stage increases over that shown in curve *A*. This is due to the fact that, when both stages

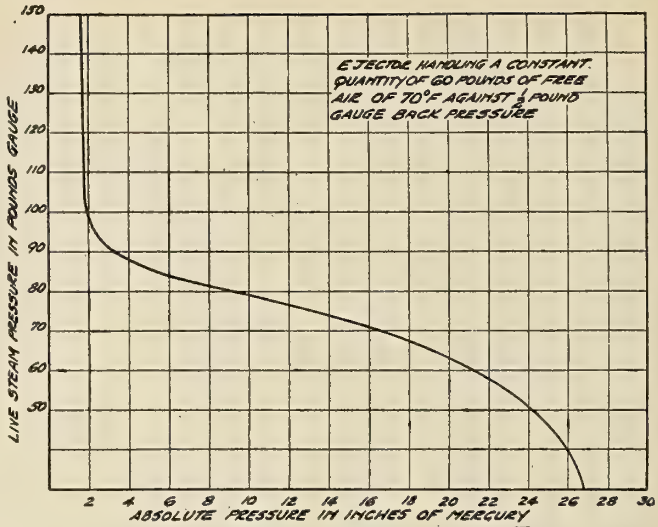


Fig. 7.—Curve Illustrating Effect of Variations in Live Steam Pressure

are working, the second stage also compresses the steam discharged from the first stage. One is accordingly led to the conclusion that it is advisable to shut off the steam supply to the first stage at about 5-inch Hg. absolute to save the live steam used in the same. Curve *C* also indicates that at about 4.5-inch Hg. absolute or more a single-stage air ejector should be used, provided it can be designed self-starting.

In connection with Fig. 6 it must not be assumed that the curves indicated are in every sense absolute. They depend entirely upon the ratio between the compression ratios of the first stage and those of the second stage. The curves shown are those of an ejector which has been extensively used in marine installations.

The main factors (excluding those referring to the design) controlling the performance of a steam-air ejector are:

(a) The quality of the live steam supplied.
(b) The pressure of the live steam supplied.
(c) The back pressure at the discharge.
(d) The condition of air handled.

The live steam supplied to the steam-air ejector should be dry saturated or slightly superheated. If less than 98 percent saturated, the losses will rapidly increase and the stability of operation will suffer. The presence of water in the steam can easily be detected by a whistling noise and a sudden drop of pressure of the steam at the pressure

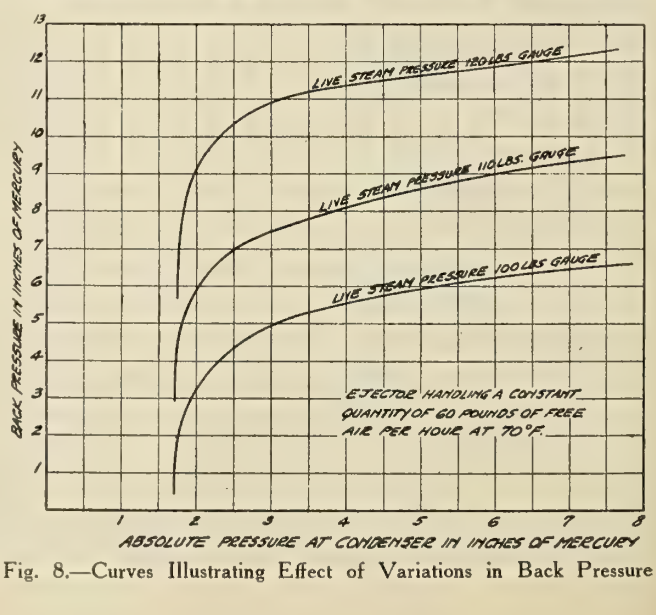


Fig. 8.—Curves Illustrating Effect of Variations in Back Pressure

gage arranged ahead of the inlet to the nozzle. If the possibility of obtaining wet steam exists, a steam separator should be provided.

High superheated steam, while good for steam turbines, does not offer any advantages for the steam-air ejector. Its compression in the diffuser becomes difficult, and this counterbalances the benefit obtained from its use in the nozzles.

The necessary minimum pressure of the live steam at the inlet to the nozzles is a function of the compression ratio the ejector has to produce. The kinetic energy of the steam, after expansion through the nozzle, has to be large enough to compress the mixture of steam and air. The minimum steam pressure employed varies from 100 to 110 pounds gage. The influence of the variation in steam pressure on a two-stage air ejector designed for 110 pounds gage removing a constant quantity of air against a constant back pressure is shown in Fig. 7. It will be noted that even low-steam pressures will produce some results.

The effect of the back pressure upon the performance is illustrated in Fig. 8, several curves for different live-steam pressures being shown. All are based upon a constant air-handling capacity. These curves also evidence the possibility of overcoming a higher back pressure by an increase in the live-steam pressure.

The effect of the conditions of the air entrained is based upon the following considerations. Air saturated with water vapors weighs considerably more than dry air. Since we can assume that the ejector will handle the same total weight whether the air is dry or saturated, the application of the Dalton Law (see Fig. 2) will enable the determination of the respective quantities. Referring to curve *A* in Fig. 6, at 2-inch Hg. absolute, 77 pounds of dry air were handled when drawn directly from the atmosphere. Assume now that fully saturated air is to be handled at the same absolute pressure and that this air has a temperature of 80 degrees F. The curves of Fig. 2 indicate the presence of 0.67 pound of water vapor to each pound of dry air in 1.66 pounds mixture. Hence the ejector would theoretically handle $\frac{77}{1.67} = 46$ pounds of dry air. Careful experiments have shown the amounts actually handled to be less than the calculated theoretical values. This is partly due to small globules of water suspended in the saturated air being carried into the ejector. An air ejector handling a mixture containing a considerable amount of vapor also has greater impact losses during entrainment and greater losses in the diffuser. The weight of mixture handled by the ejector becomes less as the proportion of vapor to dry air increases. Since the air withdrawn from a condenser is always saturated with water vapor, the above-mentioned condition should receive careful consideration when selecting the proper size of an air ejector for a condenser installation.

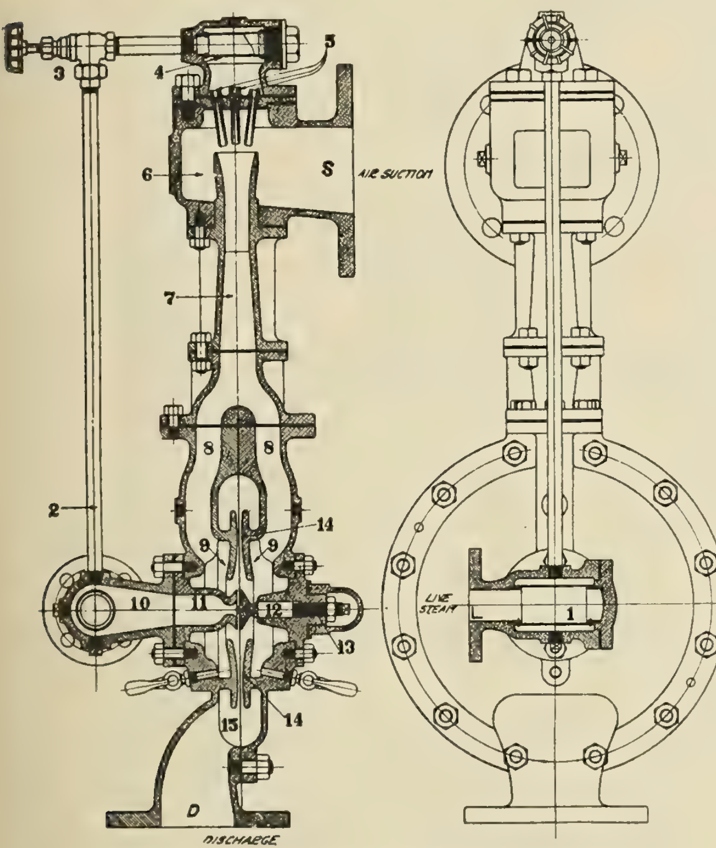


Fig. 9.—Cross Section Through Radojet Air Ejector

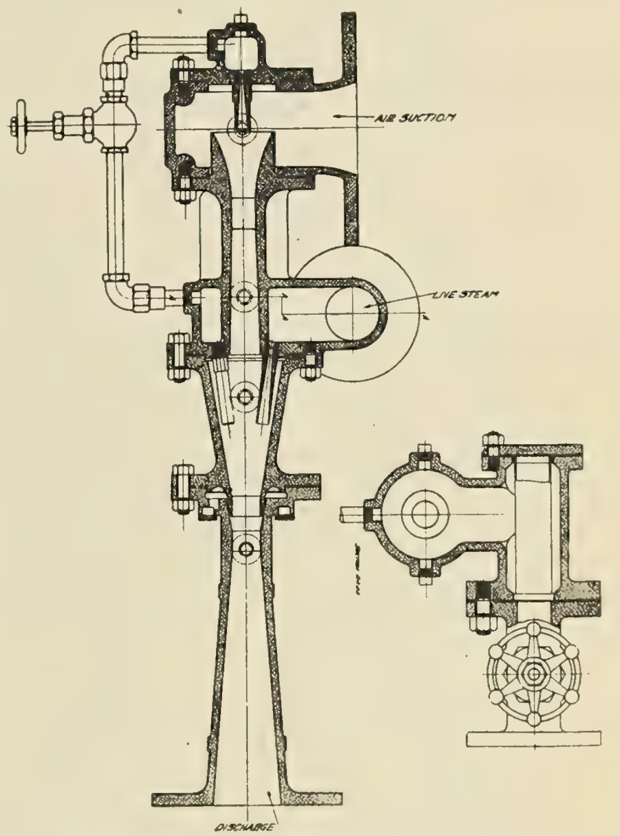


Fig. 10.—Cross Section Through Le Blanc Air Ejector

Having thus briefly indicated the principles of operation, as well as the most important factors in steam-air ejector design, several types of ejectors will be described which have been in successful operation in marine condenser installations over two years and thereby have proven their fitness for marine service. Only two types in a variety of sizes have so far been used in a large fleet of merchant marine and navy vessels.

These are known as the "Radojet" and the Le Blanc air ejector. Both are of the two-stage type, the stages being connected in series. A cross-section through the Radojet is shown in Fig. 9. Live steam is delivered from a source not shown through opening *L* through strainer screen 1, pipe 2, auxiliary steam valve 3, strainer screen 4, expansion nozzles 5, across suction chamber 6, of the

first-stage ejector, which is in communication with the condenser through the suction opening *S*.

The steam expands in the nozzles, leaving the same with a very high velocity and, while passing across suction chamber 6, entrains the air and vapors to be compressed.

The mixture passes into the diffuser 7, from where it is discharged at higher absolute pressure than that of the air entering at *S* into a double passage 8 communicating with the suction chamber 9 of the second stage. These two suction chambers 9 are annular, giving the co-mingled fluid a large entrainment surface.

Steam is simultaneously delivered through the strainer screen 1 into passage 10, which communicates with the annular expansion nozzle formed between nozzle 11 and nozzle point 12. Nozzle point 12 may be adjusted toward or away from disk 11 by the adjusting screw 13, which forms part of it, to vary the cross-section of the nozzle passage, thereby changing the expansion ratio of the steam.

The steam delivered by the annular nozzle 11 expands between the same and nozzle point 12, leaving it as a jet of high velocity in the form of an annular sheet. In passing across the section chambers 9, it entrains the co-mingled air and steam received from the first stage and carries the mixture into the annular diffuser 14, thereby compressing it to slightly above atmospheric pressure and discharging it into casing 15, which has the discharge opening *D*.

The steam nozzles of the first stage are bronze, that of the second stage is of monel metal, and the nozzle point of special steel. The diffusers are bronze. In the smaller sizes, the diffusers form part of the casing, while in the larger sizes the diffusers are secured to a cast-iron casing by bolts, forming a metal ground joint with the casing.

The strainers ahead of the nozzles protect them from becoming clogged by foreign substance. They are easily removed and are made of perforated monel metal or monel metal wire gauze. The openings in the strainers are smaller than the throat of the nozzles.

The particular features of this type of air ejector are:

1. The use of a radial jet (from which the Radojet has derived its name), which has a greater penetrating force and larger entrainment surface than that of a cylindrical jet of equal length. Consequently better efficiencies are obtained.

2. The possibility of adjusting the expansion ratio of the live steam from the outside without changing the steam consumption. Referring to Fig. 9, it will be seen that the throat is located in nozzle 11, and that any movement of the disk to or fro will not change the cross-sectional area of the throat and therefore not affect the steam consumption.

A cross-section through the "Le Blanc" air ejector is shown in Fig. 10. It has one DeLaval nozzle in the first stage, and multiple DeLaval nozzles are arranged close to the inside of the diffuser walls in the second stage. It is claimed that the losses due to the impact in the second stage are reduced, since the mixture discharged from the first stage enters the entrainment chamber of the second stage with greater velocity and in a direction nearly parallel to the steam jets of the second stage. The throat of the diffuser in the second stage also has an opening 2 connected with the atmosphere. The object of this opening is to permit the air thus drawn in to form a flexible diffuser wall. At starting and at low vacua the pressure at the diffuser throat will be atmospheric. With the increase of vacuum this pressure will be lowered and the inrushing air will partly fill up the diffuser throat, thereby decreasing the effective area. While this arrangement conforms with the principle of self-starting as outlined above, it adds to the work of the second stage, as the air thus admitted has to be compressed and ejected.

There are also a number of other steam-air ejectors on the market, none of which to the writer's knowledge have been in operation for marine service. All of these have an inter-condenser between the first and second stage. The object of this inter-condenser is to reduce the work of the second stage by condensing the steam discharged from the first stage, thereby decreasing the total steam consumption 30 to 40 percent. While this scheme may look very attractive at first, a closer investigation will show that there is no advantage in using an inter-condenser between stages in marine installations.

On board a ship it is necessary to install a surface inter-condenser. The heat contained in the steam of the first stage is entirely lost, as it is absorbed by the circulating water. Provision has to be made for removing the

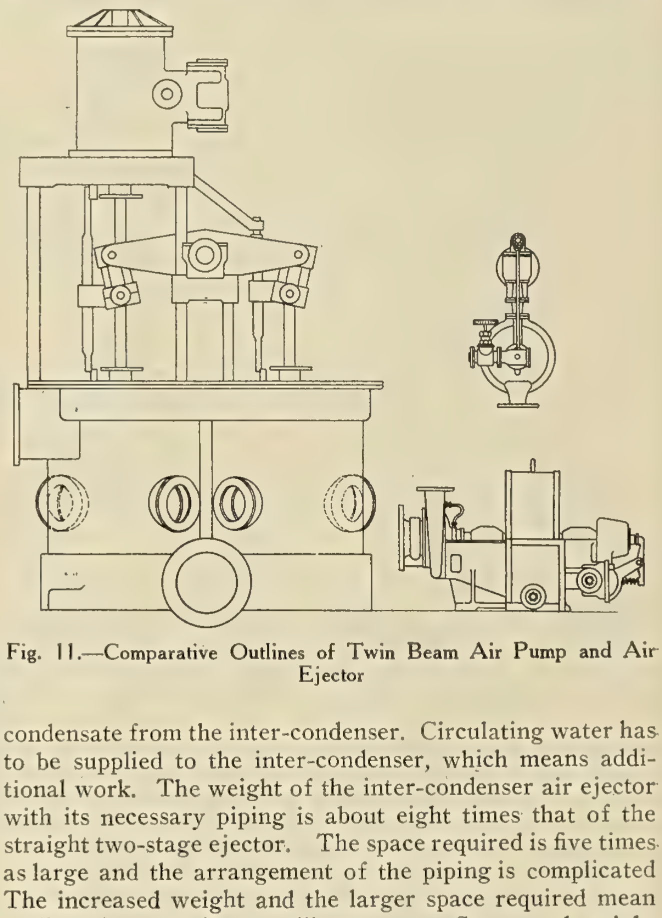


Fig. 11.—Comparative Outlines of Twin Beam Air Pump and Air Ejector

condensate from the inter-condenser. Circulating water has to be supplied to the inter-condenser, which means additional work. The weight of the inter-condenser air ejector with its necessary piping is about eight times that of the straight two-stage ejector. The space required is five times as large and the arrangement of the piping is complicated The increased weight and the larger space required mean a slight increase in propelling power. Space and weight also make it difficult to provide two or three steam-air ejectors with inter-condensers working in parallel. Such an arrangement can easily be made with a steam-air ejector without an inter-condenser, and has the advantage of increasing the flexibility and economy during light loads.

The gain in steam consumption by using the inter-condenser is more than counterbalanced by all the disadvantages mentioned. The arrangement with an inter-condenser also lacks the simplicity which a two-stage air ejector installation without inter-condenser possesses. According to the opinion of numerous marine operating engineers, simplicity is of greater practical value than the saving of a few pounds of live steam.

Until the appearance on the market of the steam-air ejector the twin-beam air pump quite monopolized the field. Therefore it will be interesting to compare the two types. Considering first the comparative steam consumptions based on equal air and condensate handling capacity

it will be found that the steam consumption of the air ejector, plus that of a turbine-driven condensate pump, is lower than that of the twin-beam air pump, even if the latter is arranged with a dry and a wet cylinder.

The weight and space requirements are also decisively in favor of the air ejector outfit. Fig. 11 illustrates a set of either type of equal air and condensate handling capacity, and Table 1 gives the relative weight, cubical space and floor space.

Table 1

	Weight Lbs.	*Cubical Space Cu. Ft.*	*Floor Space Sq. Ft.*
Twin-beam air pump....	14,500	375	33
Two air ejectors and one condensate pump......	2,100	18	8

Other comparative advantages of the air ejector are:

It has no moving parts nor valves, does not require lubrication, nor attendance during operation.

Its operation is noiseless, simple and reliable.

No foundations are required and no restriction as to location exists. It is to all intents and purposes a piece of pipe.

Since there are no moving parts there is no wear, and consequently the maintenance costs are practically nil.

When using a steam-air ejector the feed water carries less absorbed air into the boilers than when using a twin-beam pump. The condensate pump forms a self-contained unit. All the attention it requires is to see that its ring-oiling bearings are kept filled with oil. The discharge head of the condensate pump is not limited, as is the case with the twin-beam air pump. Since it operates independently from the air ejector the pump has greater flexbility and can easily take care of large amounts of condensate without influencing the air-handling capacity. This is not possible with the twin-beam air pump, in which the air-handling capacity is limited by the piston speed and simultaneously by the amount of condensate removed.

When using air ejectors and condensate pumps a considerable saving in weight and cost of piping can be made because the pipe sizes are smaller, as much higher velocities are permissible when dealing with water and air separately.

Steam-air ejectors are generally supplied in pairs for marine condenser installations, this subdivision having the advantage of reducing the steam consumption by operating with one under light loads or when the installation is air tight, also of providing additional capacity in case of unexpected leakage. In larger installations sometimes three or even four air ejectors working in parallel are being used with two condensate pumps.

This subdivision also gives an absolute assurance against a total shut-down, which may easily occur when using a single reciprocating type air pump.

As the condensate pump forms an essential part of an air-ejector installation a short description of several types of condensate pumps will be given.

A centrifugal type of condensate pump, driven directly by a steam turbine, has been extensively used. It has a single-inlet impeller mounted on the overhung end of the turbine shaft. The pump casing is bolted directly to the turbine casing, thus forming a rugged unit with only two bearings. This construction makes it impossible to throw the shaft out of alinement when bolting the pump down to the foundation or when connecting the piping. A vent is provided ahead of the inlet of the impeller and connected to the condenser to permit any air which may have been drawn into the pump through whirling of the condensate as it enters the suction pipe to return to the condenser and prevent the pump from becoming air-bound. The turbine is running at a constant speed, which is regulated by a speed governor; it also has an emergency trip. Carbon packings are generally used on the turbine glands. The pump has to remove the condensate under a high vacuum, and therefore has to overcome a suction head of 30 feet or more. This makes it necessary for the condensate to flow by gravity to the pump impeller, and it is advisable that the pump be submerged not less than 2 feet below the lowest water level of the condenser. This turbine-driven pump is supplied by the C. H. Wheeler Manufacturing Company, of Philadelphia.

Direct-acting reciprocating piston pumps, either vertical or horizontal, are also used for the removal of the condensate. Their design is adapted to the features peculiar to condensate pump service. Their submergency is more than that for the centrifugal type and is never less than 4 feet from the top of the discharge valves to the water level of the hot well. The stuffing boxes are water-sealed, and their piston speed does not exceed 25 to 30 feet per minute when handling double the normal capacity. The speed of the pump is controlled by a float arranged in the hot well of the condenser so as to prevent racing of the pump at light loads.

The arrangement of an air-ejector installation with turbine-driven condensate pump is illustrated in Fig. 12. Live steam at boiler pressure is delivered through the steam strainer to the pressure regulator; passing through the pressure regulator the steam is delivered to the main steam valve of the air ejectors at practically a constant pressure for which these have been designed to operate, the pressure regulator taking care of variation in the boiler pressure. The suction of the condenser is connected to the air suction of the ejectors by a tee, a gate valve being arranged so to permit the shut-off of each ejector. The discharge of the ejectors leads into the feed and filter tank.

A swing check valve is arranged close to the tank to prevent any water from rushing back into the air ejector if shut down before breaking the vacuum in the condenser.

Inside the feed and filter tank the mixture of steam and air is discharged through a submerged pipe perforated at the bottom. By coming into contact with the water the steam is condensed, while the air, forced to rise by the upward flow of the water, is liberated, escaping through a vent arranged in the top of the tank. Water is continuously supplied to the feed and filter tank by the turbine-driven centrifugal condensate pump, which delivers the condensate into the filter tank through a swing check valve, gate valve and a perforated pipe with holes diametrically opposite to that of the ejector discharge pipe. A vent pipe is arranged between the suction inlet of the condensate pump and the condenser.

A re-circulating pipe, with a strainer, a thermostatically operated valve and a globe valve, is provided between the feed and filter tank and the condenser to insure at all times a sufficient water supply for condensing the steam from the air ejectors.

During maneuvering or while at sea, the main engine or turbine supplying the condenser with exhaust steam may stop, consequently very little condensate will be delivered by the condensate pump to the feed and filter tank, and not sufficient to condense the discharge from the air ejector which at the time is in continuous operation.

To prevent a rise in temperature of the water in the feed tank over that desirable (usually 140 degrees F., depending, however, on the general arrangement of each

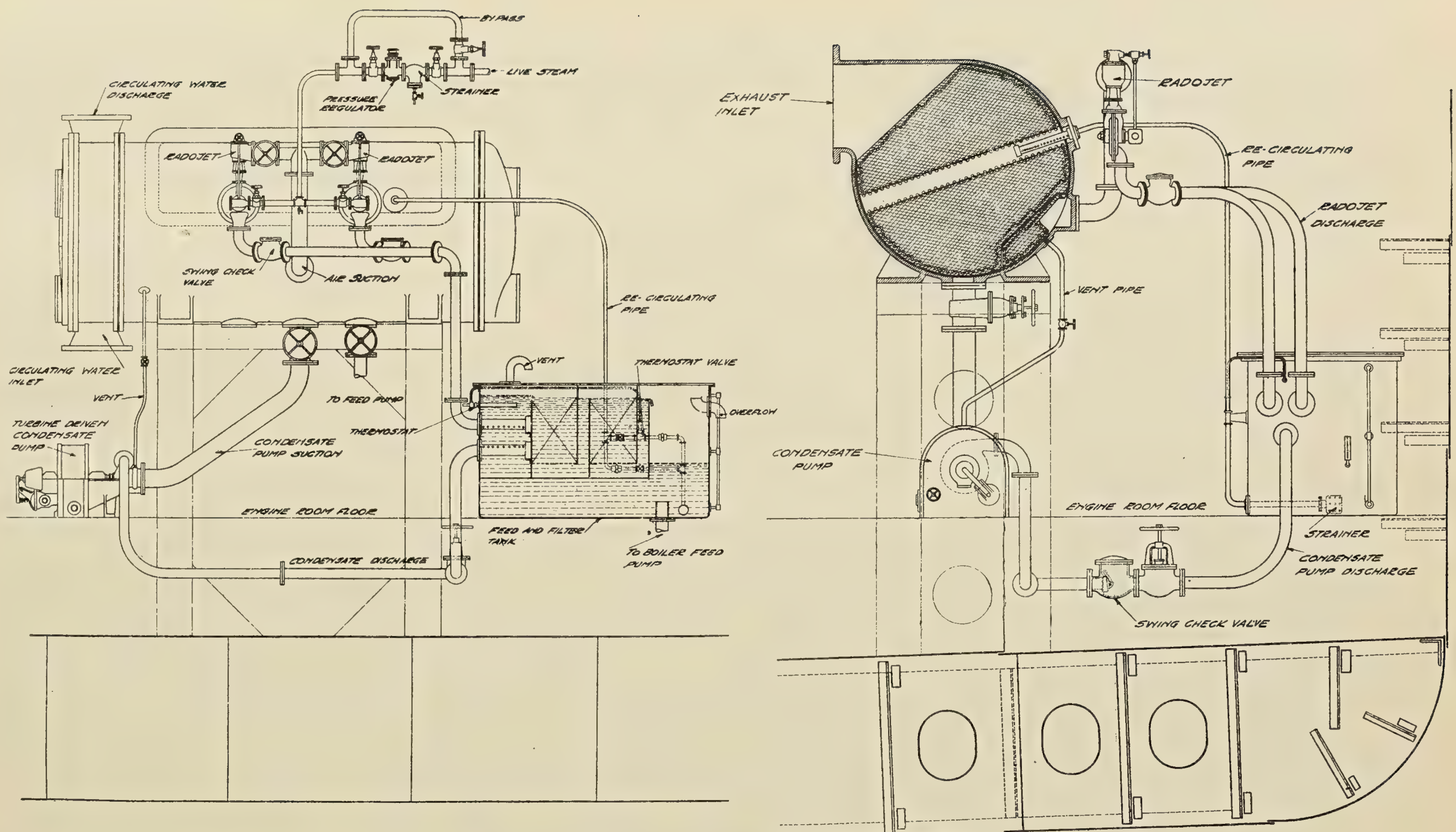


Fig. 12.—Air Ejector Installation for Marine Turbine Surface Condenser

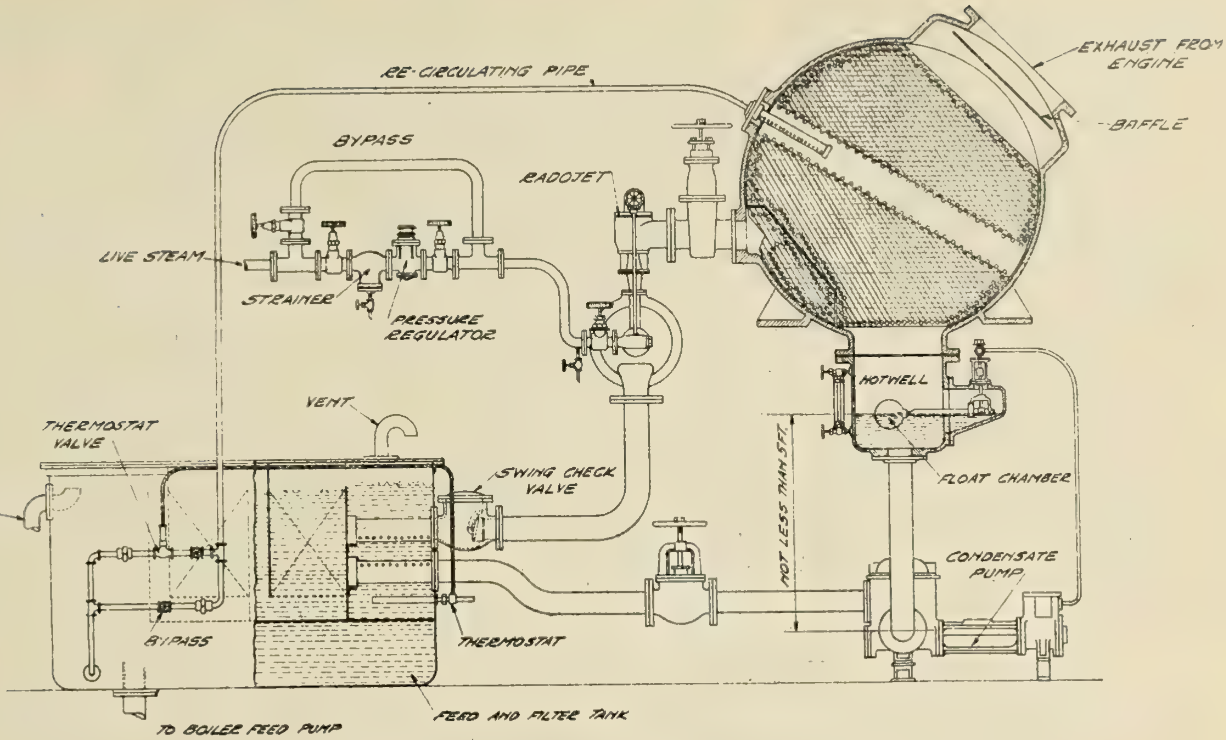


Fig. 13.—Air Ejector Installation for Marine Surface Condenser

individual installation), a thermostat is arranged in the feed and filter tank, controlling the thermostatically controlled valve. As soon as the water reaches the temperature for which the thermostat is set, the latter will open the thermostatically controlled valve and the vacuum will draw water through the re-circulating pipe into the condenser. By falling over the cool condenser tubes (the circulating pump, of course, being in operation), this water will be cooled and returned by the condensate pump to the feed and filter tank, thus preventing any further rise in temperature until the exhaust from the main engine again supplies sufficient condensate.

This arrangement makes the air ejector installation absolutely reliable, even if operated by inexperienced attendants. Starting is easy, as it requires only the opening of two steam valves, one for the turbine driving the condensate pump and one for the air ejector. During operation no attention is required, and, to shut down, only these two valves have to be closed.

A diagrammatic arrangement of an air-ejector installation with a direct-acting reciprocating piston pump is shown in Fig. 13. This arrangement is generally applied to marine reciprocating engine surface condensers, and is similar to that for marine turbine surface condensers already described. The only difference is that the speed of the reciprocating piston pump is controlled by a float arranged in the hot well.

The steam-air ejector was first tried out on board a ship about four years ago. It was feared that, by discharging the co-mingled steam and air into the feed tank, the amount of air absorbed by the feed water would be greater than that when using a reciprocating piston air pump. Comparative tests have shown that this fear was groundless. The amount of air absorbed in the feed water, when using the ejector, was 35 percent less than that when using the twin-beam air pump.

With this obstacle removed, the air ejector rapidly gained the confidence of shipbuilders and marine engineers, so that there are to-day to the writer's knowledge over five hundred ships built in this country equipped with steam-air ejectors. About one-third of these have beeen in successful operation for periods up to two years.

From this it would appear that the steam-air ejector to-day occupies a position among the air pumps similar to that occupied by the steam turbine among steam-operated prime movers. Its advantages, reliability and simplicity, are dominating factors which will gradually make its adoption as universal as that of the steam turbine.

New Motorship Added to the Glen Line

The 10,000 ton deadweight motorship *Glenluce,* built by Harland and Wolff, Glasgow, for the Glen Line, recently sailed on her first trip to China. The *Glenluce* is the eighth motor vessel built for this company and is of the standard 406-foot class, having a beam of 54 feet 2 inches.

This vessel is driven by two 1,500 horsepower, four-cycle Diesel engines constructed by Harland and Wolff. The normal speed at sea of the vessel is 11 knots, and the fuel consumption about 11 tons of oil a day, including that required by the auxiliaries.

A larger class of vessels will soon be put into commission for this company. Four which are building now will have a carrying capacity of 13,000-tons deadweight, and be fitted with twin-screw machinery of 6,400 horsepower.

The East Asiatic Company, Copenhagen, Denmark, has on order at the present time seven motorships, each with a carrying capacity of 13,600-tons deadweight. When launched, these ships, which are 485 feet in length, and fitted with twin-screw machinery of 6,000 indicated horsepower, will comprise one of the largest fleets of motor vessels in the world. The ships will have a speed of 12½ knots under full load at sea.

Development of Warrior River Barge Canal*

Description of Terminals and Transfer Facilities—Cost of Water Transportation in Restricted Channels—Prospects for Future Development

BY MAJOR ROBERT S. THOMAS, CORPS OF ENGINEERS, U. S. A.

The more important terminals and transfer stations on the Warrior River barge canal are indicated in the following table:

TABLE III.—TERMINAL FACILITIES

Character of Facilities	Purpose for Which Used	Above Mobile — Location	Miles
Transfer station	Transfer of miscellaneous freight from boat to banks	Warrior River near Demopolis	235.9
Transfer Derricks	Handling lumber and miscellaneous material	Warrior River near Demopolis	299.5
Transfer Derricks	Handling lumber and miscellaneous material	Warrior River near Demopolis	334
Transfer derrick and wharf	Transfer of miscellaneous freight from wharf boats to barges	Black Warrior River near Tuscaloosa	364.5
Loading station	Loading coal, slag, coke, and pig iron onto barges	Black Warrior River near Holt	366.25
Loading station	Loading coal into barges	Black Warrior River	369.5
Loading station	Loading coal into barges	Black Warrior River	371.
Loading station	Loading coal into barges	Black Warrior River	413.25
Loading station	Loading coal into barges	Mulberry Fork of Black Warrior	420
Wharf	Handling of miscellaneous freight	Mulberry Fork of Black Warrior	420
Transfer station	Transferring freight from railroad cars to boats or barges	Locust Fork of Black Warrior	434
Loading station	Loading coal onto barges	Mulberry Fork of Black Warrior	438.75

In addition to these there are many inclined railroad tracks connected with small wooden warehouses for use of miscellaneous plantation supplies delivered by the packet boats between Demopolis and Mobile. The above mentioned terminals are privately owned and used generally for special purposes.

The coal tipples are of many varieties of design, Fig. 7 shows one type where the mouth of a creek has been bridged by an open trestle. The coal is brought several miles from the mines by rail and is loaded from bottom dump cars on the trestle to the barges in the creek below. Fig. 8 shows a bankside tipple for the transfer of coal from the mine to the barge.

The first municipal development on the river above Mobile has been that of the city of Tuscaloosa. The site is above Lock and Dam No. 12 about a mile and a quarter above the city at a suburban park, which has been purchased by the city from the local street railway company. This tract comprises about 200 acres and has about a mile and one half of river frontage. Connection with the city and with the railroads is by the tracks of the electric car line, the freight cars being handled by an electric engine to an exchange track in the city, where they are delivered to the respective railroads, who absorb the switching charges. There is now a passable highway, but the plans contemplate an improved highway of good grades and even surface.

Within reach of the barges in the river, of the railroad tracks and of the warehouse a 5-ton stiff leg steel guy derrick has been installed on concrete foundation. The derrick has a 100-foot boom and a 115-foot mast, upon a concrete pier which rests upon 17 foundation piles of 20-foot penetration. The stiff leg is 145 feet long. The derrick is figured to handle an ordinary capacity load of 15 tons and has been tested to 25 tons. The derrick was supplied by the American Hoist and Derrick Company, of St. Paul, Minn.

The present warehouse is the first unit of any number of warehouses that may be constructed later as the future may demand. It is located about 75 feet from the river bank upon cement piers which support a timber floor at an elevation well above any known high water.

*Concluded from March issue.

Since the installation of the derrick in June, 1919, considerable business has been done in transferring timber from the barges to the railroads. Pending a determination of actual operation costs a tentative price of 75 cents (3/1½) per 1,000 feet has been the charge for this service.

One of the best signs of awakened interest in the use of this inland waterway is to be seen in the shipments of steel that are now being made from Birmingham via Tuscaloosa terminal to the shipbuilding yards at the Chickasaw works near Mobile. The derrick at Tuscaloosa is not equipped as yet with a magnet so that the steel plates and rails are handled by slings. The first load of these plates was handled by a green crew in the rain, yet they were able to make one complete cycle every three minutes, which included hitching to the steel in the car, lifting and swinging and placing on the barge, unhitching and swinging back to the car. Three hundred tons were transferred in 8 hours at a field cost for crew and coal of $15 (3/2/6).

On top of the steel the barge load was completed with lumber. The tow handled by the *Volcano* included this barge of steel and lumber and three other barges of coal with top loads of lumber. The daily press of December 19 mentioned the first shipment of steel rails by all-water route from the steel mills of North Alabama to Cuba. The five carloads of rails were produced at Ensley, Ala., near Birmingham, transferred to the barges at Tuscaloosa, and from them transferred to one of the United Fruit Company's boats at Mobile for shipment to its plant at Preston, Cuba.

Birmingham Terminals

Although the city of Birmingham is some score or more miles from the Warrior river, the business interests of that city have recently incorporated a stock company for the development of the "Port of Birmingham." Press reports state that a capital stock of about $200,000 (£41,000) has been subscribed. The plans have received the required approval of the War Department and the contract was to have been let some days ago. The transfer station is to be located down stream from Ensley Southern Bridge, over the Locust Fork near Short Creek, about 419 miles from Mobile. On the east bank of the river at this place a side hill cut will be made into the steep hills that form this bank and upon this cut will be run several tracks parallel to the waterfront, but above high water. Loco-

Fig. 7.—Coal Loading Station at Mouth of Cane Creek, on Mulberry Fork of Black Warrior River, Cordova, Ala.

motive cranes will be used for hoisting the steel containers and other heavy commodities. Ore bins with chutes will be provided for loading coal, iron ore, slag and such commodities. Steel anchor rods are to be placed in the rock to form anchors for guys to prevent the overturning of the locomotive cranes when handling heavy loads. These plans are for an ad interim station in order not to delay further the starting of the flow of traffic from Birmingham by way of the Warrior river, while further investigation is being made for a more extensive and more permanent layout.

A commodity survey indicates a possible expected annual tonnage through the Warrior river terminals of nearly one and one-half millions of tons inbound, valued at $16,145,500 (£3,400,000) and 162,000 tons outbound, valued at nearly eight million dollars (£1,640,000), the ratio of outbound to inbound being 9 to 1 in tonnage and 2 to 1 in value.

Demopolis

The Commercial Club of this city now has under advisement the matter of raising by local capital a representative stock company for the purpose of installing and operating a water terminal at that city. There is available city-owned property at the top of a very nearly vertical chalk hluff over the river and well above any known high water. The requirements would be simply a hoisting derrick of sufficient capacity to handle the steel containers, a warehouse and a short stretch of a spur track to connect with the railroad.

Mobile

Mobile has its municipally-owned covered wharf that is open to all shippers on equal terms. A small charge is made to prevent abuse of the storage privilege. The city commissioners have agreed to install a derrick of sufficient capacity to handle the steel containers contingent upon the established use of these containers or the delivery of a certain number. In the meantime there are available one or more derrick boats in the harbor.

There is much talk in the local press about the etsablishment of a modern coaling station in the harbor for bunker and export purposes. The method of procedure proposed has been for the United States Railroad Administration to construct, own and operate the plant underwritten by the coal operators who are supposed to guarantee the success of the undertaking. No final conclusion has yet been arrived at.

Fig. 8.—Coal Loading Station on Mulberry Fork of Black Warrior River, Ala., a Mile Above Mobile, Ala., Looking Upstream

At the present time the actual costs of operating the boats of the Railroad Administration and of the packet lines are not available, but a very interesting and a very representative study of this phase of the problem was published by G. K. Little, United States assistant engineer on the Warrior river, in the *Professional Memoirs, Corps of Engineers U. S. A. and Engineering Department at large*, for May-June, 1916. The study was made for the particular purpose of obtaining data bearing upon the problem of economics of restricted channels.

Cost of Water Transportation

Accurate data were obtained as to the volume of traffic and the length of time consumed in the round trip over the most tortuous and most tedious portions of this canalized river that portion inclusive of Dam 17 to Dam 4. This round trip between the two dams inclusive required travel over 314 miles, involved thirty lockages and involved handling and flanking through the narrowest and crookedest part of the river. The time of these observations covered a period of four months, of which two months were during low water and two months at high stage. The costs of operating were based upon known costs for similar units and items as paid on government work. The estimates for three western river sternwheel towboats with two barge tows, average load, between 1,000 to 1,200 tons; average time of round trips, between four and six days; time of best round trips, 3 days and 3 hours, give the costs per ton mile for the average round trips for the three towboats respectively 2.74 mills, 1.99 mills, and 2.23 mills respectively; for the best round trip 2.06 mills, 1.47 mills, and 1.53 mills per ton mile, respectively. For the larger sternwheel towboat with three barge tows; average load, 1.763 tons; average time for round trip, five days and five hours; best time for round trip, five days and one hour with a load of 1,800 tons—for this the cost was 1.72 mills per ton mile for the average round trip and 1.63 mills per ton mile for the best round trip.

The data for the self-propelled steel barges previously described covered thirty round trips; the average load for the several barges were from 637 to 797 tons; average time per round trips, 3 days and 18 hours to four days and three hours; the time of best round trips, two days and eighteen hours to three days and ten hours; cost per ton mile per average trip, from 2.04 mills to 2.32 mills. Lowest cost per ton mile for the best trip was 1.45 mills per ton mile. These costs included 6 percent interest in the first cost of plant, and 6½ percent insurance, 20 percent depreciation and maintenance and fixed expenses of operation.

It is interesting to note that costs for the sternwheel towboats and the self-propelled barges were practically the same, about 2¼ mills per ton mile. Applying these rates to the distances from the mines to Mobile and to New Orleans the water cost would have amounted to 94½ cents (3/11¼) and $1.305 (5/5¼) per ton respectively, which compared to the rail rates on export and bunker coal of $1.00 (4/2) to Mobile and $1.25 (5/2½) to New Orleans would hardly justify mine owners with rail connections in attempting to use the river route. Mr. Little points out that these estimates are based upon the costs of traveling over the slowest portion of the route. By taking into consideration the greater speed actually obtained in the deeper and wider river after passing the lower lock, the costs were in 1916 approximately 74 cents (3/1) per ton delivering at Mobile and $1.00 (4/2) per ton for delivering at New Orleans, including toll charges of the Lake Borgne Canal, or a cost of about 20 percent less than the rail rate.

Since Mr. Little's study was published in 1916 the increased cost of labor and of supplies has no doubt increased the operating costs by at least 20 percent. On the other hand under the present management and with the increased experience of the crews and management certain economies in methods have been effected, though it is extremely doubtful that these can offset the great increase in the cost of labor and supplies. The above estimates were correctly based upon the cost per round trip, with the return trip empty. Nor do these estimates include interest on the nine million dollars (£1,850,000) expended by the Federal Government in development of this canalized river nor the quarter million dollars (£51,250) annum required to operate and care for this system of locks and dams.

It should not be overlooked that the above estimates of the actual cost of transportation by water are compared with the existing freight rates *as charged* and that very little information is available as to the *actual cost* to the railroads of the transportation of same commodities to and from the same points. It is well known, however, that to points where there has existed actual or potential water competition the freight rates on like commodities are less than to points without such water competition, even though the distance from point of origin to destination be ever so much less. And it is also well known that under existing system of charges many railroads are piling up a deficit.

The existing condition of affairs would appear to confirm the obvious conclusions from the foregoing; for at the present time with an all-year-round navigation of over 6-foot depth, with an established boat line operating with economy and under intelligent supervision, with unlimited production of steel and coal at one end of the waterway and a practically unlimited demand for the same commodities at the other end, the traffic on the river is practically limited to the output of about three mines which are situated upon or only a short distance from the water's edge, to the transportation of logs and timber and to miscellaneous merchandise to and from those planters who have no railroad facilities within reasonable reach.

Conclusions

After nearly fifty years of investigation, experimentation, maintenance and progressive construction the Federal Government has provided for the Southern coal and iron region of the Birmingham district and for the timber and farming sections of western Alabama a canalized river that offers for over 400 miles facilities for navigation not possessed to so great a degree by any other system of inland waterways in the United States at a cost to date of over 12 million dollars (£2,460,000) for improvement and maintenance and at a cost of over a quarter million dollars (£51,250) per annum for the continued maintenance, care and free operating of the same.

This waterway has the following advantages:

(a) Slack water except at times of floods.
(b) A practical depth of 8 feet.
(c) A width of channel of not less than 125 feet in a few of the bends, but with generally a minimum width of 150 feet.
(d) Navigation possible the year round, uninterrupted by ice or by floods or by low water.
(e) Production of coal and steel at the upper end—commodities especially suited for water transportation.
(f) Market for these commodities at the lower end.

With all of the foregoing advantages, but with the

present railroad rate structure, and with the present equipment and with one-way traffic, water transportation is barely, if at all, profitable to the water carrier.

If the business and commerce of the country are to derive the full advantages from the large expenditure of public funds and from the almost ideal system of navigable waters resulting therefrom, all or a portion of the following steps are necessary:

(1) Re-adjustment of existing "water compelled" freight rates, due consideration being given to

(a) Costs of service to the railroads.
(b) Cost of similar service to the water carrier.
(c) Equity and fairness to those commodities not situated upon the inland waterways.
(d) Water competition must be actual rather than potential, in order to be considered.

(2) Joint rates between rail and water carriers—on a fair and equitable basis. In general most river banks are either barren hills or overflowed fields and are not especially productive. Traffic originates at a distance from the river and often the ultimate destination is at a distance from the water. The boats cannot leave the water to go and get these commodities. The commodities must be brought to the boats. The charge for the delivery of these commodities from the producer to the water front should be reasonable and non-discriminatory.

(3) Adequate terminal facilities for the storage, protection and economical transfer of the commodities from the land to the boats and vice versa.

(4) Improved and more economical plant and design of the water carriers.

(5) Increased volume of water-borne traffic with a corresponding reduction in overhead rates.

(6) A large increase in the amount of return cargo to be handled.

Prospects of the Future of This Development

The navigable condition of the waterway is already a practical fact, indeed navigation on this stream is accomplished with less difficulty than on other river systems in the United States.

Terminal facilities have been installed at one city, Tuscaloosa, and are being successfully operated. The city of Birmingham is now undertaking in earnest the establishment of its terminals. The prospects are that sooner or later the city of Demopolis will follow suit and the city of Mobile is committed to the establishment of terminal appliances whenever the need for them becomes positively evident.

Towboats and barges designed in the light of most modern experience are now being constructed for the United States Railroad Administration for operations on this river, and one of these towboats is soon to be launched.

The establishment of derricks at the principal terminals, together with the use of steel containers, promises to afford a more economical method of transfer and to eliminate the losses due to weather and theft that have so militated against water transportation in the past.

Joint rail and water rates have been authorized and are now being prepared for publication, whereby commodities can be shipped from Mobile and New Orleans to points in northern and central Alabama and northern Mississippi by water to Demopolis and Birmingham and thence by rail.

The principle of a 20 percent differential under the existing rail rates has been established for the water rates.

All of the above will greatly aid in increasing the upstream volume of traffic by permitting safe and economical shipments of such perishable products as salt, sugar and rice from Louisiana, and coffee, grain and hay, which are collected at New Orleans and Mobile. Demopolis being in an agricultural and stock-raising section and a possible jobbing point, the establishment of terminals there is especially desirable as a factor for increasing the volume of upstream traffic.

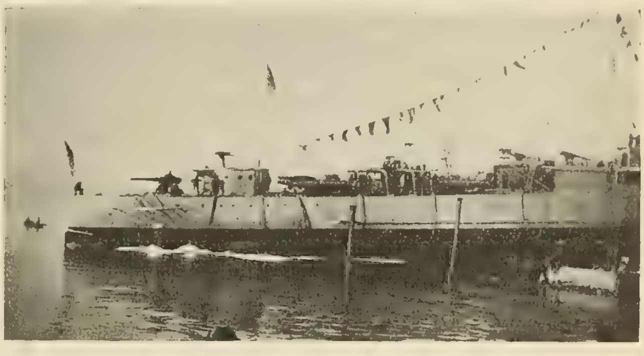
In sum, the present indications are that the local business interests are just beginning to awaken to the opportunity that lies at their door; and the logical and carefully considered steps that have been taken indicate an intelligent and well-guided progressive public interest.

The prospects for the future are indeed encouraging.

Launching of Destroyers at Newport News

On February 14 two destroyers for the United States Navy were launched at the yard of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va. The first launched was the *Abel P. Upsuhr*, and the second the *Hunt*.

These were the first ships ever launched from these ways, as they were a part of the Newport News' war programme, and the vessels were much nearer completion than is usual at this time of launching, due to the fact that no other vessels were waiting to use the ways.



U. S. S. *Hunt*, Launched February 14, Newport News Shipbuilding & Dry Dock Company

Both destroyers are of the type being built at this and other yards, the Navy numbers being 194 and 195, respectively.

Newport News Shipbuilding & Dry Dock Company Building 20,000-Ton Tankers for Standard Oil Company

Two oil tankers, of 20,000 tons deadweight capacity each, are under construction for the Standard Oil Company of New Jersey at the yards of the Newport News Shipbuilding and Dry Dock Company, Newport News, Va. These vessels are 555 feet long between perpendiculars, 75 feet beam and 43 feet 3 inches depth. They are designed for a speed of 10¾ knots, and will be provided with two sets of triple expansion engines with cylinders 23 inches, 39½ inches and 68 inches diameter by 45 inches stroke, capable of developing 3,800 indicated horsepower. Steam will be supplied at a working pressure of 200 pounds per square inch by three Scotch boilers each 17 feet diameter and 12 feet long. In each vessel will be installed four pumps, supplied by the National Transit Pump and Engine Company, each having a capacity of 2,200 barrels per hour.

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National Marine Week

NATIONAL MARINE WEEK (April 12-17) stands for American independence on the sea. It marks the awakening of the American people, as a nation, to their obligations and opportunities for extending their commerce and influence to the four corners of the globe by American ships and American agencies. It signifies the restoration of the American merchant marine in foreign trade. Commercially, industrially and politically, it marks the beginning of a new era in the life of the nation, the benefits of which are not confined to marine interests alone but which extend to every phase of the country's activities. National Marine Week stands for independence on the sea! Where do you stand?

Motorship Building

THAT the United States with its great natural advantages in the production of fuel oil should lag so far behind other nations in the building of motorships is astounding in view of the fact that the feasibility, reliability and economy of motorships have become so thoroughly established in other countries less fovored in the matter of fuel oil supplies. Between 110 and 120 motorships, the majority of which are about 10,000 tons deadweight, are now on order in European shipyards. As a matter of fact, every marine oil engine manufacturer in Great Britain and on the Continent has so much work on hand that it is impossible to undertake new orders or give deliveries within a year or eighteen months. Ninety percent of these vessels are of standardized types, falling into three general classes; first, vessels of 13,000 to 13,500 tons; second, vessels of 9,500 to 10,000 tons, and, third, vessels of about 6,500 tons deadweight. More than four-fifths of the engines to be installed in these ships are of the Diesel four-cycle type. As evidence of the reliability of this type of vessel, the first large Diesel-engined motorship built, the *Selandia*, constructed by Burmeister and Wain at Copenhagen, Denmark, has been in regular service for eight years on 30- to 40-day non-stop runs covering in all some 400,000 miles without serious breakdown. Other vessels are giving equally reliable service, and it is significant that each of the shipowners who has gained experience with motorships, when placing repeat orders, invariably contracts for vessels fitted with Diesel engines. As our London correspondent points out elsewhere in this issue, had motorships been unreliable or costly in upkeep, this condition would not exist. Although some progress is now being made in the United States in the building of large Diesel engines for ship propulsion, the fact remains that American shipowners and shipbuilders have been far outdistanced in this branch of marine engineering, and have a heavy handicap to overcome in order to match the lead of their rivals across the sea.

The Institution of Naval Architects

AMONG the events of special interest during the past month was the annual meeting of the Institution of Naval Architects held in London on March 24 to 26. The programme of this meeting, which dealt largely with naval subjects, the economic situation of the shipbuilding industry in Great Britain and special developments in marine engineering, included the following papers:

"The Battle Cruiser *Hood*," by Sir Eustace D'Eyncourt, director of naval construction.

"German Submarines," by A. W. Johns, of the Royal Corps of Naval Constructors.

"Experimental Work in Connection with Devices for Catching Submarines," by G. S. Baker, of the National Physical Laboratory.

"Notes on Our Economic Position as a Shipbuilding Country," by Sir Alfred Yarrow.

"Further Notes on the Dimensions of Cargo Vessels," by J. Anderson.

"Freeboard and Strength of Ships," by J. Bruhn.

"Stabilization of Ships by Means of Gyroscopes," by P. R. Jackson.

"Yawing of Ships Caused by Oscillation Among Waves," by Professor K. Suyehiro.

"Effect of Size Upon the Performance of Rigid Airships," by C. I. R. Campbell and C. H. May, both of the Royal Corps of Naval Constructors.

"The Effect of Holes, Cracks and Other Discontinuities in Ships' Plating," by Professor E. G. Coker and A. L. Kemball.

"Experience and Practice in Mechanical Reduction Gears," by Engineer-Commander H. B. Tostevin, R. N.

"Balancing of Rotors and the Determining of the Position and Amount of the Balancing Weights," by J. J. King-Salter.

"Turbulent Fluid Motion and Skin Friction," by Professor T. H. Havelock.

Several of these papers will be printed in full and others in abstract form in coming issues of this journal.

The Latest United States Battleship

SINCE the signing of the armistice, work has been going on apace in the completion of the capital ships authorized by Congress in 1916, the consruction of which was held up during the war. The latest vessel of this type to take the water is the superdreadnought *Maryland*, which was launched at the yards of the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., on March 20. The *Maryland* is the fourth capital ship of the Navy to be equipped with electric drive and is a sister ship to the *California*, launched in November at the Mare Island Navy Yard, California. The *Maryland*, however, has the distinction of being the first vessel to mount 16-inch guns, and in this respect will represent a distinct advance over other ships of this class, as her main battery of eight guns will have a range greater than that of any other American warship. The vessel itself is

624 feet long, displaces 32,000 tons, and is designed for a maximum speed of 21.5 knots. The electrical propelling machinery, supplied by the General Electrical Company, consists of two turbo generator sets rated at 11,000 kilowatts each; one control board; four 7,000-horsepower propelling motors of the induction type, and six 300-kilowatt exciter sets. The capacity of the complete power plant for propulsion is 28,000 horsepower. In most respects the propelling machinery follows that of her predecessors, the *California* and *New Mexico,* which was fully described in our May, 1919, issue.

Shipbuilding and the Merchant Marine

In the shipbuilding returns published in this issue, showing the amount and character of work now in hand in American shipyards, the figures give every promise of the continuation of the prosperity which the shipyards have enjoyed as a result of the war. By the end of this year the Shipping Board programme will have been practically completed. In fact, in many of the yards this work is even now practically finished, but in almost every case, especially in the steel shipyards, the volume of new business for private account is filling the gaps made by the completion, cancellation or suspension of Shipping Board contracts, so that the yards are continuing to operate at full speed. Over a million and a quarter gross tons of steel ships are now under construction for private account, and at the present rate of progress the volume of this construction should amount to at least two million gross tons in June.

The optimism which characterizes conditions in the shipbuilding field is borne out by similar conditions in the shipping field, where the volume of business and the scale of freight rates insure prompt returns on shipping investments. Here, however, progress is hampered by the constant delay of Congress in establishing a definite Government policy for the operation of the American merchant marine and the disposal of Government-owned ships. The suggestions and opinions from leaders in the shipbuilding and shipping fields bearing on these questions, published in this issue, show that the demand for Government aid or assistance in some form or other is practically unanimous, but between the shipbuilders and shipowners there is a difference of opinion as to how this assistance should be given. The shipowners ask for the sale of Government-owned ships at a price of about $100 a ton, in order to place their investment more nearly on a par with that of the existing fleets of other countries, which were constructed before the war at low cost. On the other hand, the shipbuilders enter a strong protest against the disposal of Government ships at prices below current market values, and have unanimously endorsed a plan proposed by Homer L. Ferguson, president of the Newport News Shipbuilding and Dry Dock Company, providing for discriminating duties in favor of American shipping as a means for the advancement of the American merchant marine along lines beneficial not only to the shipbuilding industry but also to shipping and commercial interests, as well as to labor and the public.

"In seeking a Government policy," Mr. Ferguson asserts, "it seems that one which can be made applicable in all fairness to the commerce of any country would be the best one. That policy, in brief, is one which will give preferential treatment to our own ships in our own trade with any given country and will give to the vessels of that country the same treatment. On the other hand, when the vessels of a country which is not interested in the trade except as a common carrier seek to enter that trade, known as the indirect trade to such country, there shall be imposed upon such common carrier an additional burden. The principle underlying this policy is that the trade between any two countries is essentially their own business and that every country should have a merchant marine proportionate to its needs, in order that it may maintain both its economic and political independence."

A New Application of Electric Propulsion

Mechanical power was first applied to marine transportation in 1807 by Robert Fulton on the Hudson River. In the something more than one hundred years which have passed since then, steam navigation has extended to all navigable waterways of the world, and the volume of commerce that has been handled in this way has far outdistanced any possible conception or dream of its originator. Now, however, comes another inventor, William T. Donnelly, of New York, who, as described on another page of this issue, has successfully made the first application of mechanical power changed into electricity on one vessel, transmitted to another and there applied as mechanical power for the propulsion of that vessel.

The inventor of this new development, like Robert Fulton, has dreamed his dreams and, after many years, has been able to show to others the result of his work and planning. The broad and far-reaching conception and possible applications of this method of applying power for marine transportation are very clearly set forth. While they may not be entirely conclusive to the conservation members of the engineering profession, they are certainly enlightening and will undoubtedly be appreciated by all those interested in this particular field of engineering development. The inventor's long experience and notable success in other lines of marine engineering, many of which have been described and illustrated in this paper, certainly entitle his work to very careful consideration in view of the possibilities for the practical application of this means of generating, transmitting and utilizing power for marine transportation.

Certainly the present time would seem most opportune for the bringing out of a new system of transportation, promising so much greater dispatch, reliability and economy than anything heretofore applied to our harbors and inland waterways. As a matter of fact, very definite plans are now being made for the broad application of this system to inland waterway transportation, beginning with the New York State Barge Canal.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Running Shaft Lines in Steamships Under Construction

As every article that I have seen regarding the running or laying out of shaft lines in steamships under construction recommends or describes the use of piano wire or light shutters, it is thought that the method used by the Alabama Dry Dock & Shipbuilding Company, of Mobile, Ala., might prove interesting.

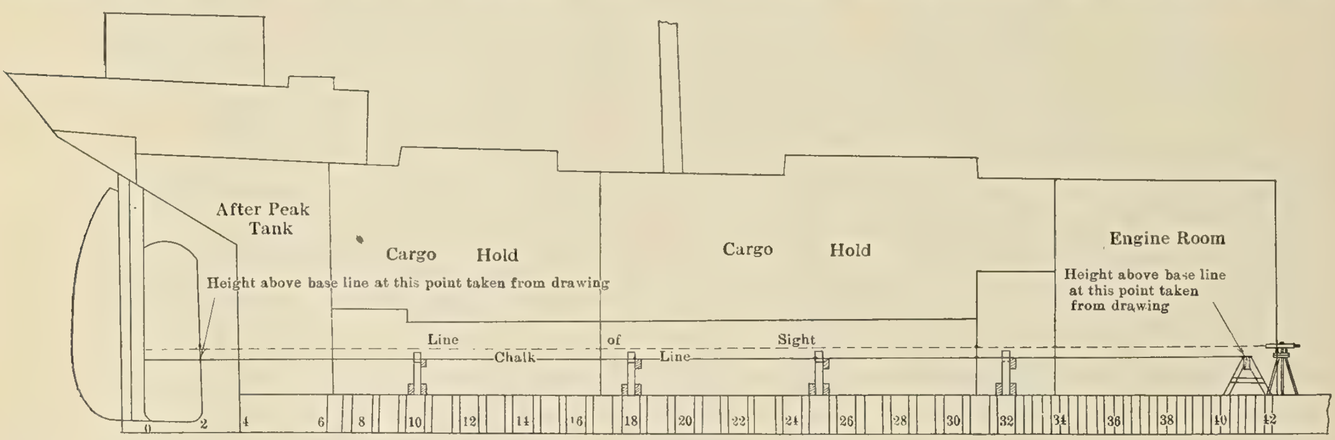
When we are ready to bore a shaft log, the exact height of the center of the shaft at the engine foundation is laid off and a support is placed at this height. Then the height of the center of the shaft at the rudder post is also marked and a chalk line is stretched between these points. A number of wooden stands with adjustable arms are then built and placed along the shaft tunnel about 20 feet apart, and the chalk line is run over these arms, which enables the line to be raised or lowered. Next, an engineer's field level is set up, and the line of sight of the instrument is made parallel to the true shaft line by reading on the two ends of the chalk line which have been fastened at proper heights, as stated above.

After the line of sight of the instrument has been made parallel to the shaft line the adjustable wooden arms over which the chalk line runs are raised or lowered as indicated by the level, until the chalk line is parallel to the line of sight. The chalk line is then pulled tight, and is the true shaft line. Measurements for boring the shaft log are then taken from this line in the usual manner.

This method of running shaft lines was used by the Alabama Dry Dock & Shipbuilding Company during the construction of the mine sweepers *Swan*, *Whippoorwill* and *Bittern,* also during the construction of the Ferris-type steamships *Banago* and *Alta,* and proved to be very accurate and efficient.

As a matter of fact, the chalk line was not necessary. The shaft line can be run with the level alone; but it was found more satisfactory to use the chalk line, as the machinists could take as many measurements as desired without the assistance of the instrument man, and, of course, have more confidence in their own observations. The accompanying sketch shows how chalk line was used.

Mobile, Ala. T. A. Johnson,
Field Engineer, Alabama Dry Dock and Shipbuilding Company.



Sketch Showing Shaft Line on Ferris Ship. Note Position of Field Level

Lathe Tool Equipment on Board Ship

I notice that the lathe tool equipment on our ships still consists of a handful of old-fashioned heavy forged tools, ordered probably by a purchasing agent whose knowledge of the requirements is perhaps limited. The writer has had the miserable experience of trying to get out work needed in a hurry with the poor assortment of tools supplied, and in the most cases they wont even fit the tool-post.

It would be a boon to the machinists on board our ships for some firm to make up a useful list of modern tools of equipment, making sure that they are suitable for the lathe tool-post. Take the case of the firms supplying the lathe, they could arrange to supply the whole equipment to cover the range of work usually occurring on board a ship; it is not wide, and a compact list of tools could be easily made up that would save lots of time, worry and expense.

The Armstrong Bros. could make up a most useful list, or the Fairbanks Company, consisting of the three bar boring tools, tool holders, cutting-off tools, threading tool, lathe dogs, clamps, Jacobs' chuck, lathe arbors ¾-inch to 2-inch Nicholsons; centering drills, Fairbanks, Fig. 7310-D style; a set of lathe arbors, Fig. 5430-B, Fairbanks, with a grinding wheel to suit ½-inch arbor, ½-inch face, 6-inch diameter, making sure that all tool bits and cutting-off tools and threading tools were ordered to suit holders and include a couple of dozen assorted bolts and a small angle plate.

The cost of a decent set of modern lathe tools would not

be a great deal more than the old-fashioned bunch of junk that usually accompanies the lathe on board, and would be of some use when required.

Bath, Me. THOMAS MATEER,
Foreman Machinist, Texas Steamship Company.

Wreck of the Liberty Glo

THE severe poundings which the modern ship will stand, and an American-built ship, a war bride if you please, are well illustrated in the case of the *Liberty Glo,* a Hog Island ship of 7,800 tons deadweight, which, on December 5, 1919, hit a submerged mine in the North Sea just off Branderis on the northern coast of Holland.

Cut from waterline to waterline through No. 2 hold, the master was able to get her into shallow water and held her there for fourteen hours, awaiting the promised assistance which never arrived. Within sight of land, right off a lighthouse and lookout station, burning distress signals of every sort, yet no visible effort was made to render the ship any assistance. When it had become evident that the ship could hold together no longer in the increasing gale, orders were given to take to the boats. The ship parted, the port side giving away first, covering

Fig. 1.—Bowless, Severely Pounded, but Still a Ship

the sea with fuel oil, bales of cotton and barreled oil, and then the starboard side let go.

The after part of the ship, driven by wind and seas, a dark, desolate shape, its hopelessness accentuated by one lone light playing around the bridge, for the master had remained with his ship, soon disappeared into the breakers. There she received a beating such as few ships ever take and still retain the semblance of a ship. After the storm had subsided and when she could be boarded from the shore it was found that she was still a ship, intact, and well worth salving.

Fig. 2.—Looking Into Hold

Fig. 3.—Method of Boarding the Ship

This, however, was the first of many poundings she was to take. She now rests high up on the beach, as can be seen from the snapshots, having been driven there by three successive storms, each one expending its fury upon the ship but unable to smash her. Her boiler and engine rooms remain intact, the pumps are used frequently to keep her dry, and with any sort of weather she will again sail the seas.

Fig. 4.—Captain and Officers of the Ship High on the Beach

The forepart has been driven up onto the beach about two miles from the after part and is slowly working its way into the sand, a total loss.

A word of praise is due the memory of the chief engineer, George H. Weston, who died from exposure in a lifeboat. During the trying moments right after the ship had been hit and while it was yet unknown what she would do, he stayed by his post, giving all that he had in the successful effort to get her in to the coast.

E. B. PERRY, Third Officer,
S. S. *Liberty Glo.*

Nes op Ameland, Nederlands.

Cleaning Out a Squirt Can

It is a very rare thing to see anybody clean out a squirt can, yet everybody knows that no receptacle will always keep clean. How the dirt gets into the cans is hard to say. The oil itself has some dirt in it, then dust settles down through the spout. Also, when a machinist pushes the spout into the oil holes in the apron of his lathe, he scrapes up the dust and dirt in these holes. Anyway, the dirt gets there and it is no easy matter to clean out a squirt can. Gasoline (petrol) and a few No. 8 shot will do the work; so will a jet of steam, but to do the work in this way requires a special rig. The spout must be cleaned also.

When a man drops a full squirt can it is quite sure to hit on the rim and, of course, is made to leak. The machinist starts for the soldering iron and tries to solder the leak, with the idea that he is saving the boss money. As the metal is oily, the solder does not flow well, but at last a big gob of solder sticks to the can. It is botch work and, as a matter of fact, makes the article cost the boss about four times as much as buying a new can.

The thing to do with a dented can is to turn it back to the store room. It does not pay to fool with it.

A squirt can usually goes with some machine, and it looks strange on a drawing board. When asked why the can was on the board, the draftsman made an ink line on the edge of the paper, then pointing the spout of the can at the line he pressed the bottom rapidly and the ink dried almost as if by magic. That was a new idea.

Norfolk, Va. George Sheath.

British Standard Ship

(*Concluded from page 276.*)

for two wireless operators. The officers, engineers and chief steward are quartered in the saloon house. The engineers' mess room and petty officers' quarters are in side houses on the shelter deck. The crew's quarters are aft in the 'tween decks, access being obtained from the deck house on the shelter deck.

Structural Arrangements

The vessels are built under the special survey of Lloyd's Register of Shipping according to the shelter deck rule, and classed 100 A-1. The keel is of the flat plate type, with overlapping butts and a centerline keelson 3 feet in height. The vessel has 6 inches rise of floor, 5 feet radius bilge and 7 inches tumble home at the shelter deck. The bilge keels are 9 inches deep, of the usual tee-bar and bulb plate type, and are fitted amidships on each side for a distance of 100 feet.

Solid plate floors are fitted on every frame, but are lightened by large manholes throughout the double bottom. One continuous line of intercostals on each side of the centerline is carried as far fore and aft as practicable, with an extra line on each side under the engines, and an extra half-depth intercostal forward of the three-fifth length amidships, to take up panting stresses.

The side frames are of bulb angles, spaced 24 inches apart throughout, and carried to the upper deck and shelter deck, alternately. Intermediate angle frames are fitted in the 'tween decks for one-fifth of the length forward and one-eighth of the length aft, and are scarfed to the main framing. No side stringers are fitted except forward, to prevent panting. The shelter and upper deck beams are bulb angles, fitted to every frame and supported by a centerline girder. The girders are in turn supported by widely spaced pillars, formed of four angles, leaving spacious holds with the least possible obstruction to the stowage of cargo. The decks are of steel throughout, and are covered with "litosilo" in way of the accommodations.

Equipment and Steering Gear

Every provision has been made for the rapid handling of cargo, each hatch being served by two derricks capable of lifting 5 tons each. Each derrick is worked by a separate 7-inch by 10-inch Clarke-Chapman winch. One derrick at No. 2 and one at No. 3 hatch are capable of lifting 10 tons, special goosenecks and sockets being fitted to the masts for housing them when handling heavy lifts. Preventer stays are also provided for supporting the masts when the heavy derricks are in use. The steam windlass was supplied by Messrs. Emerson, Walker & Thompson.

A steam steering gear, supplied by Messrs. J. Lynn & Company, is fitted at the aft end of the engine room casing, and connected to the steering quadrant by means of rods and chains. Relieving gear of the Taylor-Palaster type is fitted to the steering quadrant. Auxiliary tackle is also installed for working the rudder by means of the two after winches in case the steering gear breaks down.

Propelling Machinery

The propelling machinery, which was installed by Messrs. H. & C. Grayson, Ltd., consists of a set of triple-expansion, inverted, direct-acting, surface-condensing engines, with cylinders 21 inches, 34 inches and 56 inches diameter by 36 inches stroke, designed to develop 1,100 indicated horsepower at sea.

Steam is supplied by two single-ended, cylindrical boilers 15 feet 6 inches in diameter and 11 feet 6 inches long, working at a pressure of 180 pounds per square inch. The boilers work with natural draft, and have a total heating surface of about 5,100 square feet and a grate surface of 138 square feet.

The *Cervantes* on her trial trip steamed at 12.25 knots, and on her maiden voyage averaged 10.4 knots on a coal consumption of about 19 tons per day.

BOOK REVIEW

Hendricks' Commercial Register of the United States for Buyers and Sellers. (Twenty-eighth Annual Edition, 1919-1920.) Size, 7¼ by 9¾ inches. Pages, 2,541. New York, 1920: S. E. Hendricks Company, Inc. Price, $12.50.

The 28th annual edition of Hendricks' Commercial Register of the United States for Buyers and Sellers for 1920 has just been published, after being delayed for two months by the strike of the printers in New York. The new edition contains several improvements, the most noticeable being the new method of exterior indexing by coloring the front edge red, white and blue, to indicate the different main sections of the book.

First is blue on which is stamped the words "Trades Index." This is a section of 162 pages in which every product listed in the book is indexed and cross indexed for ready reference. The red section is the main classified trades list. It contains 1,813 pages listing over 18,000 different products. In the present edition we find over 1,200 new headings, including many headings completely covering the chemical industry. The third section of the book, as indicated by the white edges, contains 216 pages listing the trade names, under which products are manufactured, with the name and address of the manufacturer. The second blue section is the alphabetical section of 487 pages, containing all the names in the book in one alphabetical list with addresses, and their main line of business. This is followed by the index to advertisers of 20 pages, containing a full list of branch and foreign offices following each name.

It is an excellent work, a copy of which should be in every sales and purchasing department. For the former it contains complete lists of all prospective customers, and for the latter it shows at a glance the producers of any product which may be required. The list of trade headings covers from the raw material to the finished article all products connected with the electrical, engineering, hardware, iron, mechanical, mill, mining, quarrying, chemical, railroad, steel, architectural, contracting and kindred industries, and the firms listed cover producers, manufacturers, dealers and consumers.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Large Concrete Vessels

Q. (1,035).—Are concrete ships more rigid than steel? If they are flexible, does the working of the ship by hogging and sagging in a heavy sea have any effect on the concrete? What effect has oil on concrete? Have any ships of 7,000 tons or over been built in the United States and powered by heavy oil engines? Kindly furnish the following information concerning the 7,500-ton concrete oil tankers building at Mobile, Ala., for the Emergency Fleet Corporation, viz., sizes of main engine and auxiliaries, piping arrangements for pumping cargo, bulkhead connections of the piping, sizes of heating coils in tanks, i. e., their ratio of heating surface to cubical contents of cargo tanks; method of securing deck machinery to deck, also fastenings of stern tube and rudder post to hull.

A. (1035).—No tests have been made to the writer's knowledge upon the deflection of concrete ships. Concrete beams have been tested, and one type showed a deflection of 1/720th the span, the steel being under 16,000 pounds per square inch stress (Technical Papers, Bureau of Standards, No. 2, test by Humphrey and Losse). It would appear probable that the deflections of steel and concrete ships are of about the same magnitude, much less than wooden ships under similar conditions. If the bond stresses or tensile stresses are too high, thus allowing vessel to deflect too much, i. e. work, trouble would be developed showing as cracks in the concrete.

In regard to vessels propelled by heavy oil engines, the United States has built only one of over 7,000 tons, namely, the *Maumee*, a steel naval tanker of 15,000 tons displacement, having two 2,500-brake-horsepower, six-cylinder, two-cycle Diesel motors.

Mineral oil, according to Mark's Mechanical Engineer's Handbook, does not affect the strength of concrete. Although it is customary to cement the bottom of salt and fresh-water tanks aboard ships, it is not considered wise to cement wash tanks containing oil. However, inaccessible parts of tanks are often cemented, such as below the sterntube in the after-peak tank. It is necessary for concrete ships to provide a coating on all surfaces of the oil tanks to prevent oil from seeping through. Mr. R. J. Wig, in a very interesting paper read before the Society of Naval Architects and Marine Engineers, November, 1919, stated that the interiors of all oil compartments were painted with two coats of magnesium fluosilicate and three coats of spar varnish, cheese cloth being placed between each successive layer of varnish. The above paper gave the following data about the 7,500-ton oil tankers building at Mobile: Main engine, 24½ inches by 41½ inches by 72 inches and 48 inches stroke, 2,800 indicated horsepower at 88 revolutions per minute; boilers, three oil-burning Foster watertube.

Regarding the size of heating coils for fuel oil tanks, cargo and bunker, ordinary steel ship practice should hold the following as being a common value; 1 square foot of heating surface to 60 cubic feet of oil, for double bottom and deep tanks less heating surface may be used.

Drilling holes for holding-down bolts after concrete has set and grouting same in is unsatisfactory; steel reinforcing may be encountered, and, furthermore, the process is slow. Mr. Wig advises that holes be drilled in fittings, etc., from templates by which the bolts were set in the forms. For stem, stern, and rudder construction as well as other information I would refer you to the following papers; "Concrete Shipbuilding in the United States," by W. A. Scott, Institution of Naval Architects, 1919; "Ferro Concrete Ship," by T. J. Gurette, North East Coast Institution of Engineers and Shipbuilders, 1918; also papers read before the Institution of Naval Architects in 1918, and articles published in the technical press of that year.

Thickness of Copper Piping

Q. (1,036).—Please let me know if the formulas:

$$\text{Thickness, } T = \frac{D.\,W.}{6{,}000} + 1/16'', \text{ for brazed copper pipe,}$$

$$\text{and } T = \frac{D.\,W.}{6{,}000} + 1/32'', \text{ for solid drawn copper pipe,}$$

where D is the diameter of pipe in inches and W is the working pressure in pounds per square inch, hold good for main steam, water and feed pipes for piping that must comply with Lloyd's regulations? Also give allowances necessary for pipes to be bent, and state if factor of safety is taken care of by the formulas.

A. (1036).—The rules which you have stated are those of the British Board of Trade (the United States Steamboat Inspection Service at present subscribes to the first rule for the thickness of copper pipe). The Board of Trade limits the size of solid drawn copper pipe, for which the second rule applies, to 10 inches, and also states that feed pipes are to be made sufficient for a pressure 20 percent in excess of the boiler pressure. Seaton and Rounthwaite's Pocketbook of Marine Engineering gives tables of copper piping for different pressures and purposes, which should be referred to. Both the above authorities give the working pressure for the pipe, not the ultimate, i. e., the factor of safety has been taken care of by the formula. Lloyd's Register of Shipping publishes no rule for the thickness of copper pipe, but accepts that of the Board of Trade.

Regarding bends, these should not be made sharp, in order to reduce the chance of weakness in outside of bend, and also to keep down the friction and dangerous effects of water hammer. The United States Steamboat Inspection laws consider a radius at the bend of 3/2 the pipe diameter as a minimum, this, of course, being far too sharp a bend for ordinary use. Where the pipe has to be bent it is necessary to allow for the thinning at the outside of the bend by ordering the pipe one or two gages heavier than that specified. This holds true for copper pipe which is bent, and also for large copper pipe the bends of which are made in two pieces. Care should be taken to allow for the thinning of pipe in bending both copper and steel, as inspectors very often measure the thickness at the outside of the bends, and will condemn pipe which falls below the required thickness.

The Bureau of Navigation, Department of Commerce, reports 112 sailing, steam, gas and unrigged vessels of 253,579 gross tons built in the United States and officially numbered during the month of January, 1920. Over 92 percent of the tonnage consists of steel steam vessels.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

SHIPPING BOARD GIVES UP OPERATING SHIPS

Private Concerns Will Handle Vessels Under an Agency Agreement and Make Their Own Rates

Operation of the Shipping Board fleet has been given up by the Board, which will allow private operators to handle the ships under an agency agreement. At present the Shipping Board operates certain vessels and private operators handle others. Henceforth private concerns will manage all the ships, retaining a percentage of the profits.

Coincident with this new policy, the Shipping Board has given up its authority over freight and passenger rates. Private operators will now be allowed to make the rates. Action of the Shipping Board was announced in this bulletin:

"Effective March 1, 1920, all Shipping Board tariffs, including current supplements thereto, are hereby canceled in so far as the public is concerned.

"Rates hereafter may be obtained direct from managing agents of shipping vessels."

The Government retains title to its ships, and the new operating policy is not in conflict with any general law for retention of the fleet.

Under the form of agency contract approved and in use, individuals, companies or corporations can operate the vessels on a profit-sharing plan. The Fleet Corporation reserves the right to terminate the agency at any time, and the agent can terminate his agreement on 30 days' notice.

For operating purposes the vessels are valued at $200 a deadweight ton, and profits are to be reckoned on this basis. Operating agents are permitted under the contract to retain 10 percent of all net profits up to 50 cents a ton a month. On net profits over 50 cents a ton a month, and not over $1 a ton, the agent retains 20 percent, and on all profits in excess of $1 a ton a month the agent gets 25 percent.

BUILDING CARGO SHIPS FOR FOREIGN ACCOUNT

Two Under Construction in Brooklyn for Montreal Concern

The keel of the first of two steel freighters contracted for by the Donald Steamship Company, Inc., of Montreal, was laid recently in the yard of the Tebo Yacht Basin Company, Brooklyn. These freighters are to be of 1,200 deadweight tons, 227 feet over-all length, 33 feet 8 inches beam and 16 feet depth. They will be oil-burning vessels with triple expansion engines of 1,400 indicated horsepower, and will have a speed of 14 knots, and while constructed for the transportation of fruit will have accommodations for a few passengers.

The Tebo Yacht Basin is the Eastern construction yard of the Todd Shipyards Corporation, 15 Whitehall street, New York, and it has made Brooklyn a shipbuilding as well as a ship repair center. The Tebo company has already delivered sixteen hulls, including nine mine sweepers and three oil tankers for the United States Navy, and is now completing a tanker for the Sinclair Navigation Company, 120 Broadway, New York.

ORDERS MORE TANKERS

Mexican Concern Adds Four to Its Fleet

The Eagle Oil Transport Company, Ltd., a subsidiary of the Mexican Eagle Oil Company, it is announced, has placed a contract with the Standard Shipbuilding Corporation, Shooters Island, N. Y., for four oil tank steamers of 8,400 deadweight tons each for delivery late this year. They will be used to carry crude oil from the Mexican Eagle's producing properties and in the oil trade between the United States and Europe.

The Transport Company's fleet at present aggregates more than 200,000 deadweight tons.

Converting Coal Burners

How rapidly the movement for the conversion of coal-burning steamers to oil is extending is indicated by the fact that during the past few months Messrs. Smith's Dock Company, of South Shields, England, has booked orders for the fitting of oil-burning installations on board no fewer than 59 vessels of an aggregate indicated horsepower of 193,010. Included among these are ten Anchor-Brocklebank liners and twelve Furness, Withy steamers.

INSURANCE FOR EMPLOYEES

Westinghouse Electric Plan Affects About 50,000 Employees

An insurance policy for $500 will be given, entirely without cost, to every employee of the Westinghouse Electric & Manufacturing Company who has been in the service of the company for a period of six months or more, according to a statement made by one of the officials of the company. The plan is effective March 1. In addition, the employees, after April 1, may increase the value of their policies for amounts varying from $1,000 to $2,000, depending upon their length of service and continuity of savings.

All employees who have been in the company's service for six months or longer, and who deposited a sum each payday in the Employees' Savings Fund, equal to 2 percent or more of their earnings, will not only receive 4½ percent interest compounded semi-annually on such deposits, but in addition will automatically have their insurance increased to amounts up to $2,000, depending on the length of time they have been with the company.

For example, a man who has been in the service of the company for at least fifteen years, and has regularly deposited in the Employees' Savings Fund 2 percent or more of his salary, on which he regularly receives 4½ percent compound interest, is presented with an insurance policy in one of the established companies for $2,000 at no cost whatever to him.

After an employee has maintained the required deposits for five years, he may discontinue, or withdraw his deposits from the Savings Fund without in any way affecting the value of his insurance policy. To provide for cases where employees need some money and do not wish to disturb their savings, loans will be made by the company to the extent of 90 percent of the amount to the credit of the employee in the Savings Fund without in any way affecting the value of the insurance.

This insurance is to be effective at all the offices and plants of the company, and will affect approximately 50,000 people.

National Marine Week stands for American Independence on the Sea.

Where Do You Stand?

National Marine Week Exposition, Grand Central Palace, Lexington avenue and Forty-sixth street, New York,

April 12-17, 1920

SIX TANKERS ORDERED FROM NORTHWEST STEEL COMPANY

They Replace Cargo Ship Contracts Cancelled—Conversion of Japanese Built Ships Halted in Pacific Yards

Six steel tankers, of about 10,000 deadweight tons, are to be built for the Emergency Fleet Corporation by the Northwest Steel Company, of Portland, Ore. This announcement confirms the statement printed in Ships and Shipping on February 27, which said that a big contract was going to the company.

Originally the Emergency Fleet Corporation planned to build six freighters at the Portland yard of the Northwest Steel Company, but, in view of the anticipated shortage of tonnage to move fuel oil to the various stations, which have been projected by the Shipping Board, it was decided that additional tankers were needed. Hence it was argued that the Northwest Steel Company should build tankers instead of freighters.

While more than a half million gross tons of tankers are building for private interests in American shipyards, the Government has fifty-two oil carriers of a total deadweight capacity of 498,675 tons on the ways or contracted for. The Government has a fleet of forty-eight tank steamers in operation at the present time.

When the Government embraced an oil-burning programme the outlook was more favorable than it is now. It was not anticipated that the large petroleum producers would be unable to fill the requirements of the Shipping Board at a reasonably low figure. One of the results of the failure to contract for the 1920 oil requirements has been the decision of the Shipping Board not to convert all of the freighters which it had built by Japanese and Chinese shipbuilding yards.

More than half the ships ordered from builders in the Far East have been launched and a number of deliveries have been effected. The first group of the Japanese ships was immediately turned over to the repair yards on the Pacific for conversion into oil burners. However, when it developed that there would be difficulty in obtaining fuel oil for the fleet the Emergency Fleet Corporation issued instructions that the other freighters should remain on a coal-burning basis.

The demand for tankers continues in spite of the fact that private interests have recently placed contracts for a vast number of oil carriers. It is reported that one prominent firm of naval constructors is preparing plans for a fleet of eight ships, bids for which will be asked from builders within the next few days.

MARINE WEEK PLANS

Revised Programme for the Celebration—Navy to Have Exhibit

A revised programme for the observance of National Marine Week, at the Grand Central Palace, Lexington avenue and Forty-seventh street, New York, is announced by the National Marine League, 268 Pearl street, as follows:

Monday, April 12—1 P. M. Inaugural luncheon aboard an American ship in New York Harbor, at which the ceremonies of the week will be opened formally by the Secretary of Commerce and the Chairman of the Shipping Board.

4 P. M. Formal opening of the National Marine Exposition by the Chairman of the Shipping Board at a private viewing, Grand Central Palace.

8 P. M. Shipbuilding Night at the Exposition.

Tuesday, April 13—7 P. M. Annual dinner of the National Marine League, Commodore Hotel, New York. Speakers will include the Secretary of the Interior and the Chairman of the Shipping Board.

Wednesday, April 14—8 P. M. Engineering Night. Special lectures and motion pictures at the Exposition.

Thursday, April 15—8 P. M. Travel Night. "Travel in American Ships" featured as a slogan at dinner, and celebrated under the auspices of the Travelers Club of America.

Friday, April 16—8 P. M. Fuel Night. Special lectures and motion pictures at the Exposition.

Saturday, April 17—8 P. M. Merchant Mariners' Night. Special films and features to stimulate recruiting of Americans for the merchant marine service.

The Navy Department is the third Federal branch to announce its participation in National Marine Week. Following orders issued by Secretary Daniels, the Navy is preparing an elabroate and unusually interesting exhibit, featuring naval appurtenances never before on view to the public.

The other two Government departments which will take part are the Shipping Board and the Department of Commerce, which will be represented by exhibits of the Bureaus of Navigation, Lighthouses, Steamboat Inspection and Fisheries.

The celebration of Fuel Day has been placed in the hands of a committee of the prominent coal and oil men, headed by F. S. Staley, president of the Fuel Oil Engineers Association. The other members include: H. C. Matlack, of the Matlack Coal and Iron Company; C. C. Smith, assistant general secretary of the American Petroleum Institute; Lindon C. Bates, consulting engineer, and Frank Shipman, of the Texas Company.

A committee to take charge of Engineers' Day was also formed at a recent luncheon meeting. It is composed of H. L. Aldrich, chairman; Capt. C. A. McAllister, secretary of the Shipping Board committee to revise navigation laws; and Walter MacFarland, authority and writer on marine engineering. William T. Donnelly, naval architect and marine engineer, will be one of the speakers.

PREPARING FOR BUSINESS

Anglo-American Oil Investing Heavily in Depots and Bunker Stations

Word comes from London that the Anglo-American Oil Company is building factories, filling stations and depots at various places, such as Avonmouth, Newport, the Manchester Ship Canal and Brilham, also on the Clyde and Humber, at an expenditure of several millions of pounds.

This work represents arrears of progress arrested by the war, and also involves provision for the increasing demand for oil products, notably for purposes of steamer bunkering.

The Scottish-American Oil Company, formed last November, is also understood to be negotiating for the control of the Trinidad Central Company, owning concessions of the 70,000 acres in the island of Trinidad.

New Practical Safety Device

Emery wheels, rotary cutting machines, etc., are a constant source of danger to the workman's eyes. With "safety first" being preached by trained organizations of safety men in all big industrial establishments, any device designed to protect the worker's eyes from injury is of general interest. Goggles and glass shields have proven fairly satisfactory, but not entirely so because of the liability of the glass to become broken. Recently safety glass and transparent sheeting (the same material used for lights in auto curtains) have been tried with great success. The safety glass is made either by laying it in a coarse mesh of fine wire, or by employing hydraulic pressure to weld a piece of the transparent sheeting between two sheets of glass.

However, for goggles or shields over emery wheels the transparent sheeting alone is very effective. It is cheaper and lighter than any form of glass. Fire glass (having the wire in it), safety glass or the transparent sheeting alone can be fitted in an oblong frame to be imposed over the wheel in such a position as to deflect emery dust and metal particles away from the operator's eyes.

The fire glass is not suitable for goggles, but the safety glass or the sheeting alone is all right for the purpose.

AMERICAN RED CROSS PLANS TO HELP AMERICAN SAILORS

Bureau of Marine Service Will Be Operated By Seaport Chapters—Needed In the Far East

A special service for the boys who man our merchant ships has been inaugurated by the American Red Cross in the new Bureau of Marine Service. This work will be carried on by the seaport chapters of the American Red Cross all over the world.

A reading and writing room to which sailors may repair for rest and recreation, and which they may use as their headquarters while in port, has been urged on Red Cross chapters as the solution of a long-felt need for American sailors in foreign cities. A chapter member will act as hostess to look after the comfort of the transient guests.

Some cities already have a seamen's home, and in these places the Red Cross will co-operate with this existing agency and supplement its service.

American shipping has increased enormously. More and more seamen are needed to meet the after-war demands of trade expansion. The United States Shipping Board is endeavoring to meet this situation by raising the standard of the seaman's calling, so that a fine type of young American may be persuaded to enlist.

"It will fill a big need in the Orient," said Julian Arnold, a former Red Cross division field representative in China, when told of the new Bureau of Marine Service. "There are no provisions in such ports as Shanghai, Hongkong or Manila for entertainment of a wholesome nature for the American sailor. He is expected to be an outcast and to associate with the dregs of humanity. And how many self-respecting men can be expected under these conditions to choose to follow the sea?

"If America is to build up her merchant marine in a way which will be a permanent asset, careful consideration must be given to its personnel. This means improved conditions for the men that man the ships. Accommodations should be provided in every port which will permit the sailor to have wholesome entertainment under decent auspices. There should be an American reading room where newspapers, writing material, etc., are supplied. There should also be recreational facilities as provided by any club."

This work, Mr. Arnold feels, will be enthusiastically welcomed by American Red Cross members in these seaport cities.

"In Shanghai," he said, "there is an American population of 2,000, who are under the protection and laws of the United States and are not subject to the laws of China. It therefore would be an easy matter to carry on this work under American auspices. Since Americans there are enthusiastic over all outdoor sports—football, baseball, rowing, tennis, etc.—it would not be difficult to provide facilities by which the American sailors might participate

OIL AT $1.34 TO $2.07

Shipping Board Buys 11,000,000 Barrels

Fuel oil contracts covering a total of 11,000,000 barrels, at prices ranging from $1.34 to $2.07 a barrel, have been placed by the Shipping Board for the six months' period beginning April 1.

The contracts were made with the Mexican Petroleum Corporation, 120 Broadway; the Atlantic Gulf Oil Corporation, 11 Broadway, and the Standard Oil Company of New Jersey, 26 Broadway, New York, and cover deliveries at various Atlantic ports between New York and Galveston.

Morgan Firm Represented in Submarine Boat Directorate

Henry R. Carse, president of the Submarine Boat Corporation, 5 Nassau street, stated to the directors at the annual meeting a few days ago that the company had plans for the construction of a fabricated vessel of larger dimensions than the present 5,350-ton ship.

Perhaps the most important development was the election of Thomas Cochran, of the firm of J. P. Morgan & Company, to the board of directors. This was thought to be quite significant, as indicating the entrance of Morgan money into shipbuilding operations.

Westinghouse to Enlarge Its Turbine Plant

The Westinghouse Electric & Manufacturing Company, 165 Broadway, New York, announces that it has awarded to the Westinghouse, Church, Kerr Company, 37 Wall street, New York, the contract to erect four new buildings at its South Philadelphia plant, Lester, Pa., which is devoted to the manufacture of land and marine turbines. These new buildings, which will be of terra cotta and steel, will be of the highest grade of construction throughout, and will consist of a shop for building small turbines, a new machine shop, an addition to the erecting shop, and a new warehouse.

National Marine Week stands for American Independence on the Sea. Where Do You Stand?

MARINE OIL ENGINES IN INDIA

American Machinery Being Used in Large Vessels

An increasing market for marine oil engines in India is noted in the English publication *Commerce,* which says that numbers of moderate-sized wooden motor vessels are now being built in that country for coastal and overseas trade.

An interesting example of this development is shown in the auxiliary barque *Ajrabia Khatoon,* which is built of wood entirely by native labor. She is 130 feet in length, with a beam of 30 feet and a depth of 20 feet, the fuel tanks having a capacity of 3,000 gallons. The machinery installation comprises two 100 brake-horsepower Fairbanks-Morse hot-bulb oil engines, while in addition there is an electric lighting set and two motor hoists, all driven by Fairbanks-Morse engines. The installation was carried out by Pyne, Hughman & Company, of Calcutta.

Reuter reports that among other motor vessels under construction in India are several of 1,000 to 1,500 tons, equipped with hot-bulb oil engines of British or American manufacture.

Rubel Brothers' Refrigerating Concern

The refrigerating plant of Rubel Brothers, East New York, is a typical example of the high efficiency attained by the modern ice-producing plant. Completed in the early part of 1919, production has been practically continuous throughout the season, and an average output of some 240 tons of ice per day is recorded.

The closed type 14 by 16-inch ammonia compressors, belt driven from two 175-horsepower Westinghouse motors, are the principal compressors, but two 25-ton compressors operated by 50-horsepower Westinghouse motors are also installed as supplementary machines. Air compressor duty is performed by three compressors, operated by 30-horsepower Westinghouse motors. Central station power, furnished by the Brooklyn Edison Company, is used, and motors are AC type. There are two refrigerating rooms, one on the ground floor and one on the first floor, in which some 3,020 cans are housed, with necessary brine agitating equipment. The latter is driven by eight Westinghouse 3-horsepower motors.

Well water is used from artesian wells sunk upon the premises, and pumped by three 20-horsepower Westinghouse motor operated pumps. Two water pumps, driven by three and five-horsepower motors, are used for circulating purposes. Storage space is afforded for 100,000 cakes of ice, which are transported from the refrigerating rooms to the storage room by means of three elevators operated by Westinghouse 5-horsepower motors.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIP CONTRACTS

The Kruse & Banks Shipyards, Coos Bay, Oregon, has laid a keel for a steam schooner for private interests.

Tankers, Portland, Ore.—Six steel tankers of about 10,000 deadweight tons will be built for the Emergency Fleet Corporation by the Northwest Steel Company.

Motor Launch, Staten Island.—The Staten Island Shipbuilding Company has been awarded a contract for a steel motor launch for the Standard Oil Company of New York.

Tankers, Harriman, Pa.—It is announced that the Merchant Shipbuilding Corporation has taken a contract to construct six steel tankers of 12,000 tons each, at a total cost of about $11,250,000.

Fruiters, New York.—It is reported that the Atlantic Fruit Company, 61 Broadway, is seeking bids for the construction of vessels of about 2,500 to 3,000 deadweight tons, for use in its fruit trade.

Steel Hull, Washington, D. C.—The United States Engineer's Office War Department is having specifications made for a steel hull to replace the wooden one of the U. S. dredge Grosselete.

Barges, Florence, Ala.—The United States Engineer's Office, War Department, Washington, has let contract for building ten barges for Wilson Dam to the Murnan Shipbuilding Corporation, Mobile. Price, $7,468.

Tankers, Boston, Mass.—The Cochrane-Harper interests of Boston have placed contracts with the Merchant Shipbuilding Corporation, 165 Broadway, New York, for two 10,000-ton tankers of 10½ knots' speed.

Steel Hull, Nashville, Tenn.—The United States Engineer Office, 4th and 1st National Bank Building, let contract for building a steel derrick boat hull to the Howard Ship Yard & Dock Company, Jeffersonville, Ind. $14,973.

Steel Barges, Vicksburg, Miss.—United States Engineer Office, Third Mississippi River District, P. O. Box 404, will receive sealed proposals until 11 o'clock, April 10, for constructing three steel barges. Information on application.

Not a Subsidiary.—The Saginaw Shipbuilding Company, Saginaw, Mich., referring to an item in March Marine Engineering, wishes announcement made that it is not a subsidiary of the American Shipbuilding Company of Cleveland, Ohio.

Tanker, Chester, Pa.—The Department of Commerce reports that an 8,000 gross ton oil tanker will be built by the Sun Shipbuilding Company, of Chester, Pa., for the Société Anonyme D'Armement, D'Industrie, et de Commerce, a French organization.

Changing Steamship, Jacksonville, Fla.—The Merrill-Stevens Shipbuilding Corporation has contract for changing the steamer Otsego, formerly the Prince Eitel Frederick. She will be made a passenger ship of the highest grade and her machinery will be completely overhauled. Contract price, $1,000,000.

Steel Catamarans, New York.—United States Engineer Office, War Department, Washington, D. C., let contract for steel catamarans for dredging in San Juan Harbor, Porto Rico, to Greenlie Halliday Company, 499 Water street. About $46,000.

Complete Wooden Hulls, Portland, Ore.—The Monarch Shipbuilding Company will complete two wooden hulls now on the ways of the Grant Smith-Porter Shipbuilding Company. One will be made a sailing schooner, but plans for the other have not been completed.

Tankers, Staten Island, N. Y.—The Standard Shipbuilding Corporation, Shooters Island, has received contract for four tank steamers of 8,400 tons deadweight, for delivery late this year, from the Eagle Oil Transport Company, a subsidiary of the Mexican Eagle Oil Company.

Steamers, Lorain, Ohio.—The American Shipbuilding Company, of Cleveland, will build four steamers of 12,000 tons each on its own account at the company's Lorain yards. The ships will be 600 feet long, 60 feet beam, and 32 feet deep. They will be completed this year and will have every modern improvement.

Schooners, Portland, Me.—The Russell Shipbuilding Company is gathering materials for two four-masted schooners of 1,300 tons each, the vessels to be afloat in October. The Cumberland Shipbuilding Company will launch a four-masted 1,000-ton schooner late in May and build another larger one immediately after.

Freighters, Chester, Pa.—The American-Hawaiian Steamship Company, 8 Bridge Street, New York, have placed an order for two 11,000-ton shelter deck freighters with the Merchant Shipbuilding Corporation. They will be equipped with Burmeister and Wain Diesel engines from the works of the Cramp Company, Philadelphia. A speed of 11 knots is calculated on.

Coast Guard Cutters, Seattle, Wash.—The Seattle North Pacific Shipbuilding Company has submitted the lowest bids for building five steel coast guard cutters, the original contract for which had been awarded to the Norway Pacific Shipbuilding Company, of Everett, Wash. The bid was a flat price of $689,000 for each ship.

Building to Continue, New Orleans.—The New Orleans shipyard of the Foundation Company, 233 Broadway, New York, is to continue operation after the completion of the company's contract with the French Government for building steamships of the non-sinkable Le Parmentier type, the last two of which are to be launched this month. Announcement was made by Mr. H. D. Bacon, manager of the New Orleans plant.

Tankers, Chester, Pa.—Two 12,500-ton tankers have been ordered by the Union Oil Company of Delaware, 120 Broadway, New York, to be delivered in March, 1921, by the Sun Shipbuilding Company, of Chester, Pa. The same company has ordered from the Merchant Shipbuilding Corporation, 165 Broadway, New York, two tankers of 10,500 tons each, to be delivered in November and December, 1920. These will be built at the Chester yards.

Converting Training Ship, San Francisco, Cal.—The training ship Iris of the Sea Training Bureau of the Shipping Board is to be converted into a combination freighter and training vessel, according to Henry Avila, San Francisco chief of the service. The sleeping quarters will be reduced, and the vessel put into a regular freight-carrying service, which will give apprentices more practical training and make the service nearly self-supporting.

Freighters, Brooklyn.—The Tebo Yacht Basin Company, Brooklyn, has laid the keel for the first of two steel freighters for the Donald Steamship Company, Inc., of Montreal. They are to be 227 feet over all, 33 feet 8 inches beam, and 16 feet deep, oil burners, with triple-expansion engines of 1,400 indicated horsepower, and a speed of 14 knots. The Tebo concern is the eastern construction yard of the Todd Shipyards Corporation, 15 Whitehall street, New York.

Wooden Tankers, Seattle.—Five of the wooden hulls tied up in Lake Union, Seattle, have been bought by A. A. Daugherty, of the National Shipbuilding Company, 1608 Woolworth Building, New York City, and are to be converted into tankers carrying from 35,000 to 40,000 barrels of oil each. No steel will be used except for the caisson around the engine room, the tanks being of wood and fashioned of bulkheads. The cost of the hulls with their machinery and equipment was $775,000. J. H. Price Construction Company will do the work at the Meacham & Babcock plant.

PORT IMPROVEMENTS

Marine Railways, Oakland, Cal.—The Moore Shipbuilding Company is to build two marine railways with a capacity of 6,600 tons each.

Sea Wall, Trenton, N. J.—The City Commission plans to build a 1,700-foot sea wall along Assanpink Creek. About $150,000. Address F. W. Donnelly, mayor.

Dry Dock, Alameda, Cal.—The Bethlehem Shipbuilding Corporation, Ltd., will soon begin the building of a 10,000-ton floating dry dock, according to recent announcement.

Bulkhead, Astoria, Ore.—Sanitary Reclamation Committee plans to issue $200,000 bonds to build bulkheads for reclamation work along waterfront. G. T. McClean is engineer.

Wharf, Etc., Sitka, Alaska—Spec. 4151.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to build at Jafronski Island, involving an expenditure of about $16,000.

Dredging, Detroit, Mich.—The United States Engineer Office will receive sealed proposals until 11 A. M., April 15, 1920, for dredging at Rouge River, Mich. Further information on request.

Channel, New York.—The United States Engineer Office, 39 Whitehall street, will submit specifications for channel, 20 feet deep, 800 feet wide, up to Nairn Linoleum Works at Kearney, N. J.

Dredging, New Jersey.—The United States Engineer Office, 39 Whitehall street, New York, will have specifications made for maintenance dredging in Keyport Harbor, N. J.; also in Shrewsbury River, N. J.

Breakwater, Cleveland, N. Y.—E. S. Walsh, Superintendent Department of Public Works, Albany, N. Y., let contract protecting breakwater at Cleveland Terminal. Contract 28-A to E. Dawley, Cleveland, $13,260.

Piers, Baltimore, Md.—The Terminal Warehouse Company, Davis and Pleasant streets, will construct two piers and warehouse, 575 by 150 feet and 583 by 150 feet; waterway 200 feet wide between.

Breakwater, Crescent City, Cal.—Government engineers have approved a contract for building a $200,000 breakwater, a third of a mile long. DeNorte County will then be opened to settlement and industry.

Terminal, Cairo, Ill.—The city has recently purchased from a private company, which owned the waterfront, all their right and title to same, and will erect a terminal suitable for the needs of that locality.

Breakwater, Milwaukee.—The Sewerage Commission let contract for building pile and timber breakwater at east side of Jones Island, to Great Lakes Dredging & Dock Company, West Water street. $275,930.

Steel Sheet Piling, Louisville, Ky.—The United States Engineer Office will receive proposals for furnishing and delivering steel sheet piling for Lock No. 44, Ohio River, until April 9, 1920. Information on request.

Lock, Allegheny River, Pittsburgh, Pa.—The United States Engineer Office will receive sealed proposals for constructing Lock No. 5, Allegheny River, near Schenley, Pa., until noon, April 16, 1920. Information on request.

Dock, Milwaukee, Wis.—The Chicago, Racine & Milwaukee Line, Broadway and Erie avenues, are having plans prepared for a 400-foot reinforced concrete and pile dock. A. E. Hecht, 64 West Randolph street, Chicago, is engineer.

Dredging, Long Beach, Cal.—Belmont Pier Tract Company let contract for dredging 700,000 cubic yards from Alamits Bay and filling old canal and lowlands to United Dredging Company, Central Building, Los Angeles, $0.144 per yard.

Jetty Construction and Repairs, Wilmington, Del.—The United States Engineer Office will receive sealed bids for jetty construction and repairs at the mouth of the Mispillion River, Delaware, until 11 A. M., April 5. Further information on request.

Dredging and Repairing Breakwaters, Milwaukee, Wis.—The United States Engineer's Office, Federal Building, has approved specifications for dredging, repairing and riprapping 1,000 feet south breakwater in Ludington Harbor. Cost, $110,788.

Grain Elevator, Canton, Md.—Five ships can be accommodated at one time at the new grain elevator of the Pennsylvania Railroad Company put into operation recently, and which has a capacity of 4,257,000 bushels. Cars are unloaded by the tilting plan.

Dredging, Mobile, Ala.—Dredging the Mobile River near the Eslava street dock of the Alabama Dry Dock & Shipbuilding Company to a depth of 18 feet was started recently. When completed, the work will give a large amount of additional dock room.

Dry Dock, Vancouver, Wash.—Plans have been filed by representatives of David Rodgers, of Seattle, for a dry dock at Vancouver, Wash., which, if accepted, will probably be followed by the investment of $15,000,000 of British capital in the Burrard Inlet.

Concrete and Steel Shop, Quincy, Mass.—Bethlehem Shipbuilding Corporation, Ltd., soon will let contract for building a three-story 50 by 220-foot concrete and steel shop, reinforced concrete flooring, concrete foundation, at Fore River. About $75,000. Private plans.

Steamer Dock, Vancouver, Wash.—The city is having plans prepared for building first unit of new steamer dock, 964 feet frontage, concrete and steel, with frame wood piling, including 100 by 500-foot warehouse. About $130,000. A. C. Shumway, Vancouver, engineer.

Wharf, Etc., Astoria, Ore.—G. W. Sandborn Company let contract for building 500-foot wharf, 125-foot railway extension from railroad to pier headline, two 50 by 100-foot slips, 40 by 75-foot pier and warehouse to Gilpin Construction Company, Astoria. About $70,000.

Dredging, Providence, R. I.—Sealed proposals for dredging in Connecticut River below Hartford, Conn., will be received here until 2 o'clock P. M., April 1, 1920, by the United States Engineer Office, Providence, R. I., and then opened. Information on application.

Rock for Lighthouses, Sand Island, Ala.—Sealed proposals will be opened by the Superintendent of Lighthouses, New Orleans, Ala., 2 P. M., April 8, 1920, for furnishing and placing 1,800 tons of rock around Sand Island Lighthouse, Ala. Information upon application.

Extending Plant, Chester, Pa.—The Sun Shipbuilding Company plans a 600-foot dry dock, also a wet dock 600 feet by 200, with additional ways and shops. Ships up to 20,000 tons may be handled on the new ways. The improvements are expected to cost about $3,000,000.

Removing Wreck, Hudson River, New York.—United States Engineer Office, 39 Whitehall street, let contract for removing wreck of schooner May E. Lynch in Hudson River Channel, 1st District, to Merritt & Chapman Towing & Wrecking Company, 17 Battery Place, New York.

Terminal, Peoria, Ill.—Plans have been prepared by the City Engineers for a terminal consisting of either a dock parallel with the river and extending out into the lake, or two piers similar to those used at ocean terminals extending out into the bay. A temporary dock is being used.

Radio Plant, Seattle, Wash.—By the installation of a radio plant on the outer end of Pier 1, vessels anchored in the bay will be afforded free communication with others by wireless. This is said to be the only plant in the United States installed for the accommodation of vessels anchored in a port.

Machine Shop, Wharves, Docks, Etc., Norfolk, Va.—The Norfolk Shipbuilding & Dry Dock Corporation, 494-526 Argyle avenue, plans to construct seven or eight buildings, machine shop, also wharves, docks etc., involving cost of over $100,000. Neubauer & Supourtz, 929 Chestnut street, Philadelphia, engineers.

Removing Island, Houston, Tex.—An island in the Houston Ship Channel, opposite Deepwater, below the turning basin, is to be removed, according to plans by which the island has been made available for removal by the Government. A second turning basin will be dredged at the island, it has been announced.

Dry Dock and Oil Station, Wilmington, N. C.—With progress in deepening the channel of the Cape Fear River between Wilmington and Southport, efforts of Wilmington shipping men to secure a modern dry dock, fuel station and a sub-coaling station for the port have been redoubled and are likely to succeed.

Dredging, Wilmington, Del.—Work on the improvement of the Chesapeake and Delaware Canal will probably be started this summer, according to Lieut.-Col. J. P. Jervey, who has been asked to submit a program showing the order to which the various parts of the work should be executed. Dredging on the river will be started April 1.

Wharf, Etc., and Dredging, City of Everett, Mass.—Application for permission to build a pile wharf and dolphins and to dredge in Mystic River has been made to the State Department of Public Works, Division of Public Lands, by the Beacon Oil Company. Plans outlining the proposed work have been filed at the office of the department.

Fuel Oil Terminal, Seattle, Wash.—The General Petroleum Company's new fuel oil terminal on Harbor Island became a factor in North Pacific commerce with the arrival of its first cargo of 65,000 barrels of oil on the tanker Devolente. It occupies a large site at the north end of Harbor Island, and is enclosed by a 16-foot concrete wall.

Harbor Improvements, Tokyo.—The Japanese Consul at Washington announces that his government is to make Tokyo a big seaport and will spend 350,000,000 yen in the next ten years in extensive dredging operations and the construction of breakwaters. This will obviate the necessity of ships having to go to Yokohama, eighteen miles distant.

Rat-Proofing, New Orleans, La.—Dr. M. S. Lombard, of the United States Public Health Service, served notice on the commercial interests of New Orleans that unless the dock board, railroads and other interests speeded up the work of rat-proofing at least one wharf and one railroad terminal a month, the Government would be obliged to quarantine the port.

Port Improvement, Wilmington, Del.—It is announced that the bulkhead type of construction will be provided for in the decision of the Board of Harbor Commissioners for the $3,000,000 port project on the Lobdell tract. The location of the property at the junction of the Christiana and Delaware rivers makes this type of harbor the only feasible one for the site.

Developing Waterfront Terminals, Providence, R. I.—Edward G. Buckland, president of the New Haven Railroad, urges the development of transportation in Providence mainly between Kettle Point and Gaspee Point or Conimicut, and that New Haven should develop its waterfront terminals and co-ordinate them more thoroughly with its rail lines and freight yards.

Dredging, Wauna, Ore.—A communication received by the Port of Astoria Commission from the Crossett Western Lumber Company asks that dredging be done in front of the plant at Wauna. They want the cutting of a waterway between two deep pockets, a distance of 3,000 feet, 300 feet wide and five feet deep. The commission agreed to do this dredging as soon as present projects are completed.

Freight Sheds and Piers, Stapleton, S. I., New York.—Murray Hulbert, Commissioner of Docks, Pier A, North River, N. Y., let contract for building new freight sheds and appurtenances on Piers 6, 7, 8, 9, 10 and 11 to Bethlehem Steel Bridge Corporation, 111 Broadway, New York. $2,577,950. Also let contract for furnishing labor and material for building Piers 6, 7, 8, 9, 10 and 11 to Terry & Tench, Grand Central Terminal, New York. $3,252,570.

Dredging, Seattle, Wash.—A plan to dredge a ship waterway from the north end of Lake Washington to Bothell, a distance of 2½ miles, at an estimated cost of $1,750,650, was submitted by Port Engineer George F. Nicholson to the Seattle Port Commission for consideration. The proposed waterway would be 300 feet wide and 20 feet deep at extreme low water. At the narrowest part of the valley the width would be reduced to 200 feet and widened to a width of 250 feet at Bothell.

Improving Waterfront and Deepening Channel, Tampa, Fla.—Plans for Tampa's municipal waterfront have been ordered by the Board of Port Commissioners, and an engineer has been employed to supervise the carrying out of the plans when they have been accepted. Dredging work on the 27-foot channels in Tampa Bay is progressing, three miles having been completed and work begun on another section. The United States Dredging Company will begin its contract work in May, and the entire project should be completed in 1921.

Channels, Jamaica Bay, New York.—The deepening of Jamaica Bay Channel up to Mill Basin to a depth of 30 feet, which is part of the New York-New Jersey Harbor Development Commission plan, has been approved by the War Department. This approval carries the proviso that no work should be done and no expenditures made until plans satisfactory to the chief of engineers and Secretary of War have been submitted, with evidence that the city of New York or some other trustworthy agent will build suitable wharves and equipment. The matter is largely in the hands of Murray Hulbert, Commissioner of Docks and Director of the Port, Pier A, North River.

Piers and Dry Dock, Manila, P. I.—A fourth pier approximately 1,000 feet long and 240 feet wide is being completed early this year and a fifth pier is under construction, on which construction will probably begin at an early date. A marginal wharf 1,000 feet long has been constructed and its length is likely to be tripled within the next year. Two Government wharves will be extended and enlarged, and it is planned to pipe each pier, to enable oil-burning vessels to receive fuel as soon as they are tied up. The new piers will be equipped with every modern improvement. The anchorage depth will be dredged to a depth of 40 feet. A dry dock of the latest model will be constructed. It will be between 600 and 700 feet long and capable of caring for ships of 20,000 to 25,000 tons.

Port Improvement, Milwaukee, Wis.—Plans for improvement of the lake front at Milwaukee include pile revetment at Jones Island, contract for which has been awarded, dredging Kinnickinnic Basin, building rubble mound breakwater from Wisconsin street to the harbor entrance, 5,000 feet, six piers each 700 feet long and 300 feet wide, with slips 250 feet wide, a pier 100 feet wide, a slip for car ferry steamers, a breakwater 5,000 feet long, 700 feet from the shore south of the sewerage disposal plant space to be filled in, a cement dock on the inner side of Jones Island and other work. The docks will carry double railroad tracks, and viaducts will lead from freight sheds over the yards to the city streets. Sheds and warehouses of steel and concrete. The improvements will add fourteen miles to Milwaukee's waterfront, and the cost is estimated at $15,000,000. H. McL. Harding, 52 Vanderbilt avenue, New York, consulting engineer.

Piers, Dredging, Etc., Pearl Harbor, T. H.—The Hawaiian Territorial Government has plans under way covering the triple piers 8, 9 and 10, giving cargo space of approximately 360,000 square feet. The Harbor Board will complete this year a new pier on the site of the old channel wharf, and the dredging of the Kewalo Bay for a wharf. Extensive area off Fort and Allen streets has been acquired by the Territory and will be transformed into a continuation of Pier 10. The harbor will be widened between Pier 9 and the old quarantine wharf on Sand Island, by dredging the concrete posts and coral on the quarantine side. The eastern end of the harbor will be developed by elaborate plans adopted by the Inter-Island Steam Navigation Company. The Naval Board has recommended the expenditure of $27,000,000 at the Pearl Harbor Naval Station, in addition to large sums of contracts now under way.

SHIPBUILDING AND REPAIR PLANTS

Shipyard, Galveston, Tex.—Sudermann & Young plan marine ways, etc., at Galveston; capital, $20,000.

Repair Plant, Texas City, Tex.—The Gulf Marine Repair Works has been organized to repair vessels without interference with loading.

Dry Dock, Savannah, Ga.—The Rourke Dry Docks Company has been incorporated with $50,000 capital by John, James A. and John Z. Rourke.

Shipbuilding Plant, St. Andrews, Fla.—The St. Andrews Bay Ways Company has been organied. A 200-foot cradle and shipways are planned.

Repair Plant, Houston, Tex.—The Bedman Machine Company has closed contract with the city of Houston for operating a ship repair plant at Municipal Dock No. 1.

Dry Dock, New London, Conn.—A commission has been appointed by the mayor of New London in the matter of a dry dock and to secure data as to the cost of dredging, etc.

Resuming Work, Kewaunee, Wis.—Work on the new yards of the Wisconsin Shipbuilding & Navigation Company has been resumed and is going ahead rapidly. It was delayed by lack of railway cars.

To Sell Plant, Portland, Me.—The Cumberland Shipbuilding Company's installation plant is offered for sale by the United States Shipping Board. The plant includes about 15 acres of land, wharf and various buildings.

Would Buy Shipyard, Seattle, Wash.—An offer of $3,400,000 has been made to the Shipping Board by David Rodgers for the Skinner & Eddy shipyard No. 2 at Seattle. The Government purchased the yard two years ago for $3,874,000.

Steel Plant, Houston, Tex.—The site for a steel plant on the Houston Ship Channel has been bought by the Lone Star Bridge & Steel Works, George E. Coles, president. A marine repair shop will be operated in connection with the plant.

New Shipyard, Norfolk, Va.—The Norfolk Shipyards Company, capital $500,000, president Benjamin Lowenberg, plans building a marine railway, machine shop, foundry, woodworking shop and ways for concrete barges. The site comprises 50 acres.

Shipyard Merger, Providence, R. I.—The Lord Dry Dock Company, a combination of the Lord Construction Company and the Marine Engineering & Dry Dock Company, of Providence, has been incorporated under the laws of Delaware, with a capitalization of $20,000,000.

Marine Railway, Chelsea, Mass.—The last unit of the equipment of the Winnisimmet Shipyard, Chelsea, has recently been completed. The power house is not yet finished. The way is 680 feet long, 70 feet wide, and will cost about $750,000.

Sell Concrete Shipyard, Wilmington, N. C.—The Emergency Fleet Corporation is offering for sale the Liberty shipyard, consisting of 42 acres of land, with a river frontage of 1,600 feet. Bids will be received up to noon, April 7, 1920. The cost of the plant was approximately $800,000.

To Sell Plant, New London, Conn.—Frederick Conlin and P. LeRoy Harwood, receivers of the Groton Iron Works, formerly controlled by the Morse interests, 50 Broad street, New York, have made application to the Superior Court for permission to sell the plants in Groton and Noank.

Dry Dock, San Pedro, Cal.—The first pontoon for the dry dock for the Los Angeles Shipbuilding & Dry Dock Company has been towed to its place, and work on the other pontoons is rapid. The new dock will accommodate vessels up to 10,000 tons and will cost $1,000,000 when completed.

Dry Dock, Wilmington, N. C.—Foundations have been laid for the new pipe and cover shops at the Carolina Shipyard, a part of the shipyard repair plant now in course of construction. In addition to the repair plant, a concrete dry dock to accommodate ships up to 7,500 deadweight tons may be built, at an estimated cost of around $1,000,000.

Building and Repair Plant, Knoxville, Tenn.—The Knoxville Ways Company, recently organized, will take over one of the old boat-building yards on the Tennessee River near 14th street. A power plant will be installed, with three cradles of sufficient size to accommodate any steamer on the rivers. Timber will be obtained from local lumber mills, but other materials will be purchased in open market. Captain John Harris, H. C. Milnor and Malcolm McDermott are interested in the enterprise.

SHIPPING DEVELOPMENTS

New Steamship Service, Boston, Mass.—The New England Maritime Corporation has established a steamer service between Boston and San Francisco, via the Panama Canal.

Clyde Line Enlarges Fleet, New York.—Two steamers, the Lake Fernaldo and Lake Reo, have been added to the fleet of the Clyde Line to operate between New York and Wilmington, Del.

Atlantic-Gulf Route, Baltimore, Md.—The Southern Pacific Steamship Company has applied to the Interstate Commerce Commission for permission to operate a line from Baltimore to Houston and Galveston.

New Steamship Line, Tampa, Fla.—M. E. Gillette & Son has recently been incorporated with a capital of $1,000,000. M. E. Gillette, president; D. C. Gillette, vice-president and treasurer, and George R. McKean, secretary.

Steel Steamer Purchased, Seattle, Wash.—The steel steamship Francis L. Skinner has been sold to the Oriental Navigation Company, 17 Battery Place, New York, by the Skinner syndicate for operation on Atlantic routes.

Steamers Purchased, Wilmington, Del.—Capt. Horace Wilson, of the Wilson Line, has purchased the steamers Favorite and Pokanoket. Wilmington interests intend to use these boats in connection with their line running in Florida waters.

New Steamship Company, Baltimore, Md.—The Atlantic-Gulf and Pacific Company, a transatlantic, transpacific and coast to coast steamship enterprise, with headquarters at Baltimore, has been filed with the Maryland State Tax Commission. Capital, $2,000,000.

Freighters Purchased, Seattle, Wash.—The Green Star Steamship Company has purchased the freighter Santa Cecelia, formerly owned by W. R. Grace & Company, bringing the total number of steel steamships owned by the company to eighteen.

Steamers Wanted, Seattle, Wash.—A. F. Haines, vice-president and general manager of the Pacific Steamship Company, has applied to the Shipping Board for the allocation of six new 17½-knot passenger steamers for operation from Puget Sound to the Orient.

Coastwise Freight Line, New York.—A fortnightly freight service from New York to San Francisco was inaugurated on March 16 with the 5,350 deadweight ton Shipping Board steamer Delisle, flying the house flag of Williams, Dimond & Company, 8 Bridge street.

The Old Colony Shipping Corporation will be the Boston, Mass., agents of the Southern Transportation Company, of Baltimore, which has recently purchased a number of 2,500-ton barges from the Shipping Board, to be placed in the coal trade between Chesapeake Bay and New England ports.

Steamer Line Quits, Providence, R. I.—The Block Island, Newport and Providence Transportation Company went out of business when the steamer Juliette made her last trip to Block Island and Newport. The end of operations of the company comes primarily through the sudden deaths of Frank J. Gethro and Vincent Gethro.

New Shipping Company, Berkeley, Cal.—Extensive shipping facilities will be established on the Berkeley waterfront. With a capitalization of $250,000, the F. W. Stow Finance Company was incorporated to do shipping business by land and sea, charter vessels, build warehouses, etc. Officers are F. H. Stow, A. A. Sanders and E. B. Davies.

Steamship Company Obtains More Room, New York.—W. R. Grace & Company have purchased 84 and 86 Pearl street and 50 and 52 Water street, covering a plot of 5,600 square feet. The buyers hold title to the Grace Building at 3 and 13 Old Slip. With the property just purchased, frontage on Water street of 253 feet has been secured.

Proposed New Steamship Line, Philadelphia, Pa.—The Philadelphia Chamber of Commerce is negotiating with steamship men of Boston for a line of large steamships to sail from Boston and Philadelphia through the Panama Canal to Los Angeles, San Francisco and Seattle. Service contemplated at the outset is for three steamers of 8,500 to 10,000 tons each.

Trans-Oceanic Line, Baltimore, Md.—The Danzig-Baltimore Steamship Corporation proposes to sail a passenger and freight fleet between Baltimore and Danzig, pending the passing of the $50,000,000 authorization loan bill for harbor and pier improvements. The necessary capital has already been secured and eight ships flying the American flag will be put on the line.

Shipping Company Increases Capital, Portland, Ore.—C. M. Dant and Edward Christensen, of San Francisco, and a group of men headed by Emery & Olmstead, of Portland, have purchased the outstanding stock of the Columbia Shipping Company, operating vessels between Portland and the Orient and Europe. Capital has been increased to $2,500,000.

Schooner Bought, New York.—Seabury & deZafra, 150 Nassau street, New York, purchased the motor schooner Jayo in the interest of clients and have instructions to secure additional vessels of from 350 to 400 deadweight tons, and also one of about 800 deadweight tons for the same clients. They are also interested in steel steam or fuel oil engined vessels of similar size.

New Lines, Boston, Mass.—The Moss Line, through the International Mercantile Marine, 9 Broadway, New York, announces a service from Alexandria to Boston via Gibraltar, Algiers and Malta. Rogers & Webb also announce a new service between Boston and Marseilles, Genoa, Naples and Trieste. This company has had allocated to it the 7,800-ton steel steamer Clavarack. Future sailings will probably be monthly.

Purchase Ex-German Vessels, New York.—The Panama Railroad Steamship Line, 24 State street, New York, has arranged for the purchase of four ex-German vessels which have been operated by it for the past two years, for which, with a total tonnage of 15,569 deadweight tons, the line will pay $3,000,000. The company also purchased the Royal Mail Steam Packet Company's waterfront property at Colon, C. Z., for $250,000.

Harriman Sells Steamship Company, New York.—The Coastwise Transportation Company, recently acquired by W. Averill Harriman & Company, 165 Broadway, New York, has been sold to the American-Hawaiian Steamship Company, 8 Bridge street, New York. Through the purchase the latter company gains title to a fleet of ten steel ships with a deadweight capacity of 76,500 tons. Officials of the company announce that the entire fleet has been chartered for trans-Atlantic coal business for three years on satisfactory terms.

Freight and Passenger Lines, New York.—The Raporel Line of the Clyde Steamship Company, Pier 36, North River, has established a passenger service between New York and Hayti, Virgin Islands and the Windward Islands, and the first regular transatlantic freight service from Philadelphia to Avonmouth and Hull, England. Shipping Board tonnage has been assured the Mallory Steamship Company Pier 49, North River, for the freight service. The Raporel Line has established offices in the Commercial Trust Building, Philadelphia.

Shipping Board Sales, New York.—Shipping Board vessels sold include three cargo and passenger steamers—the Santa Theresa, 5,300 tons, the Santa Elisa, 5,300, tons and Santa Malta of 9,400 tons—for $5,250,000, also the ex-German liner Garland, 4,200 tons, for $174.60 a ton to W. R. Grace & Company. The ex-German ships—Yazoo, of 2,200 tons, and the Lake Dunmore, of 2,185 tons—were sold to Fernandez Hermanos, of Manila, for $250,000 cash on delivery and a New York concern at $200 a ton, respectively. Several small vessels were also sold by the Shipping Board. The Anderson Overseas Corporation, 165 Broadway, sold the Marshall, a 4,000 deadweight ton new steel cargo ship, to Henrik Ostward, of Bergen, Norway. The Lake Flatonia, about 4,000 deadweight tons, of the same type, was sold to the International Mercantile Company. The same corporation completed arrangements for the sale of fifteen steel ships of 3,000 tons each, of the Lake type, to foreign concerns. Ten were sold to the Lloyd Royal Belge for $6,086,000, and five to a French company for $3,100,000. An agreement was reached by the Roumanian Government with the Shipping Board for the purchase of twelve steel cargo ships of 5,100 tons. The Lake Festus, a 3,000-ton vessel, was sold to the International Maritime Corporation, 44 Whitehall street.

FOREIGN MARITIME MATTERS

Tankers, Sweden.—The Commercial College at Stockholm has granted a subsidy of 8,000,000 kroner, covering about two-thirds of the cost of two 6,000-ton tankers to be built for Swedish owners.

Marine Oil Engines for England.—It is reported that the British Government is placing orders for large marine oil engines for installation in merchant ships to be built at the Chatham, England, Dockyards.

Cargo Steamers, Sweden.—The Kockum Yard, at Malmo, has an order to build one steel cargo steamer of 6,500 tons deadweight for the Swedish America-Mexico Line. One motorship of 4,450 tons deadweight will be built at Landskrona for Rederi A. B. Sverige, Levante.

Finnish Steamer, Danzig.—The Schichau Yard, in Danzig, has received an order to build the first Finnish trans-oceanic steamer, which is to be 7,300 tons deadweight. The vessel will cost 8½ million marks and is to be completed on November 1 of this year. She will be the largest steamer of the Finnish merchant marine.

Grain Steamers, Birkenhead.—The Byron Steamship Company, Ltd., of London, has placed an order with Cammel & Company, Ltd., for the construction at their Birkenhead shipyard of two grain-carrying steamers for service in the eastern Mediterranean. The vessels will be provided with geared turbine propelling machinery.

New Shipyard, Gloucester, South Wales.—A site at the head of the Monk Meadow dock has been acquired by a private limited company for ship repairs and building. Ellis Brothers, Bigham & Morris, Limited, will have the shop and offices, and T. V. Ellis, former manager of the Finch shipyard, Chepstow, is the head of the movement. The nominal capital is 7,000 pounds sterling.

Cargo Steamers, France.—The Chantiers et Ateliers, South East, have been ordered to build two steel cargo boats of 7,000 tons deadweight each for Cie. Générale Transatlantique. Chantiers de la Loire will build four steel cargo steamers 480 feet long by 59 feet beam by 46 feet deep. They will be named Jamaique, Kerguelen, Islande, Lipari, and are for the Chargeurs Rounis.

Motorships, Newcastle.—The Otto Thoresen Line, of Christiania, Norway, is having two sister motorships built by Wood, Skinner & Company, of Newcastle-on-Tyne. They have a deadweight capacity of 2,200 tons each, 260 feet in length, and are to be fitted with a 1,400 indicated horsepower, six-cylinder engine of the Werkspoor type, built in Holland. The cylinders are 560 by 1,000 mm.

Norwegian Steamers, England.—The Norwegian firm of Fernley & Eger have placed orders with English builders for ten steamers totalling 54,000 tons deadweight. Six of these are for the Garonne Company and will be used in the timber and wood pulp trade. Two are for The Aker Company, and two for the Glitre Company. All are to be delivered in the course of the year, and all except one will use oil fuel.

Salvage Work, England.—Maritime Salvors, Ltd., a new company, has acquired a permanent base of operations at Newhaven for salvage work. It has bought two of the best salvage vessels of the United States Government, which have been renamed and are fitted up with the latest appliances, including a flame cutter so devised that an oxy-acetylene flame can be used under water to cut holes in sunken vessels for cargo and machinery salvage.

Ships to Be Built, Melbourne, Australia.—The Senior Trade Commissioner states that the Commonwealth Government has decided to build twenty ships, in addition to the existing programme. The vessels will be shelter-deck, 331 feet between perpendiculars, 48 feet beam by 33 feet 7 inches depth molded to shelter deck. They will carry about 6,000 deadweight tons on 23 feet 8 inches draft, and have a capacity of about 338,000 cubic feet. The propelling machinery will be triple-expansion engines and Babcock & Wilcox boilers capable of giving a speed of 10½ knots, and using either coal or fuel oil. It has also been decided to construct four or six larger vessels, 520 feet length overall, 62 feet 3 inches beam, by 45 feet depth molded. They will carry about 12,800 tons deadweight on 30 feet draft. Their cubic capacity will be about 700,000 feet, of which about 250,000 will be insulated for carrying frozen meat. They will have twin-screw, quadruple-expansion engines, with watertube or Scotch boilers using coal or oil fuel, developing 7,300 horsepower and a speed of 13 knots loaded.

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Fig. 1.—Waterfront of Pensacola Shipyard, Showing Building Berths

Southern Shipbuilding Activities

Steel Ships Aggregating 600,000-Deadweight Tons Built in Southern Yards Since January, 1919—Description of Pensacola Shipyard

DURING the past three years the South has made rapid advances in demonstrating the advantages of its geographical location for manufacturing enterprises. This has been brought about through the demands of the emergency requiring the establishment of additional facilities for supplying the immediate and future needs of the country. Far-seeing corporations, recognizing the necessity of uninterrupted operations to obtain maximum efficiency with minimum costs of production, have located in areas which permit the continuing of work throughout the year, without hindrance from snows and the elements of the winter months. This requirement is particularly pronounced in the shipbuilding industry, where possibly 90 percent of the work is done in the open, and favorable weather conditions are imperative to maximum success.

This great, practically new, American industry in its recent rapid expansion has met with marked success in the South, and is now represented by plants at all of the principal ports. In the southern Atlantic and Gulf district the steel shipyards have launched, delivered and placed in process of construction since January, 1919, more than 600,000 deadweight tons of steel cargo ships and tankers, and with their present equipment have an annual capacity of approximately this tonnage. These Southern

Fig. 2.—Forge Shop at Pensacola Shipyard

Fig. 3.—Steamship *Cushnoc*, Built by Pensacola Shipbuilding Company, Loading for Maiden Voyage

Fig. 4.—Launching of S. S. *City of Sherman* at Pensacola Shipyard on January 14, 1920

yards have had remarkable success in turning out ships of the highest class, and this is principally due to the favorable climatic conditions and the available supply of willing and unhampered labor.

The Pensacola Shipyard

An example of the permanency of this new Southern industry is the plant of the Pensacola Shipbuilding Company at Pensacola, Florida. This plant is located on approximately 131 acres of land, within the city limits of Pensacola and borders Bayou Chico, an inlet from Pensacola Bay. The erecting berths have a length of 2,800 feet, and provide for side launching. Fig. 4 shows the hull of a 9,000-ton ship launched with the entire ship, including mechanical work, 98 percent complete.

The layout is so arranged that steel vessels with dead-

Fig. 5.—General View of Pensacola Shipyard Looking East, Showing Fitting-Out Dock in Foreground

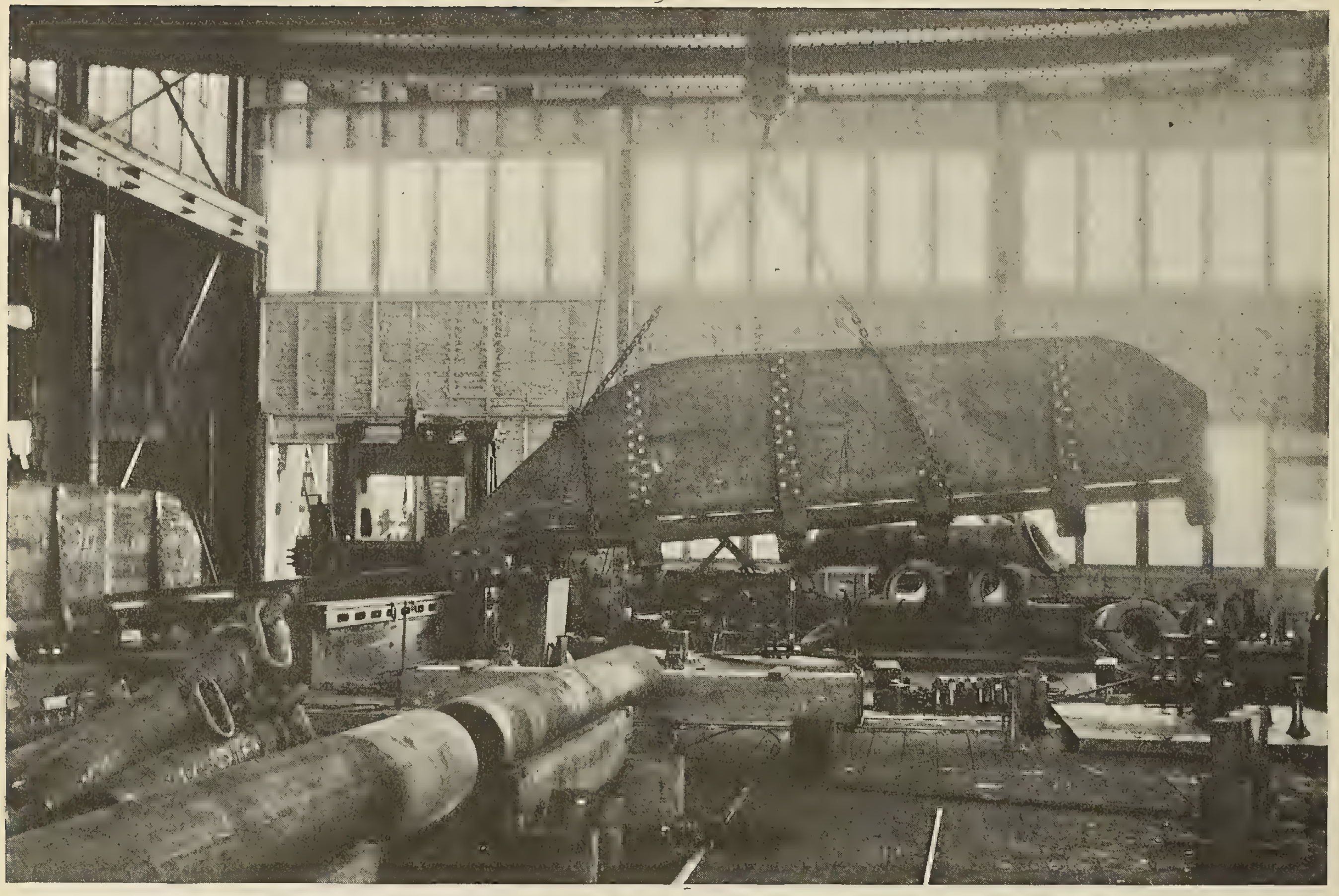


Fig. 6.—Interior of Machine Shop at Pensacola Shipyard, Showing 20-Ton Rudder on Crane

weight capacities up to 15,000 tons can be built without changing any of the equipment. At the present time these berths are accommodating five 9,000-ton deadweight capacity steel cargo ships in consecutive lengthwise positions, as noted in Fig. 1. The hulls are erected with tower gantries, which can travel the entire length of the berths. Five of these gantries are in operation, one to each hull, but they are so arranged that two or more can be concentrated on one hull, if found desirable. The gantries have 80-foot booms with capacities of 10 tons with a 30-foot reach, and five tons with the booms in a horizontal position. The gantries are electrically operated and are extremely economical on account of the one-man control. Storage racks for fabricated materials are placed close alongside of the gantries in a line parallel with the hulls, and the transferring of the steel from the racks to the hulls is done without lost motion on account of the compactness of the arrangement and the close proximity of the racks, gantries and hulls.

Layout of the Yard

This same arrangement of avoiding lost motion has been followed in the layout of the entire plant. Material entering the gate continues always in a forward motion through the shops to the docks, by means of a system of tracks which are carried on an inclination to the last hull and outfitting dock. The general arrangement of the yard is graphically shown in Fig. 5.

Outfitting Docks

The outfitting dock is a continuation of the erecting berths and has a length of 1,000 feet. This dock is provided with one 25-ton and one 50-ton stiff-leg derrick, for lifting heavy mechanical parts and outfitting materials. It is also provided with an auxiliary power equipment, machine shop, pipe shop, rigging loft, etc., making the quick handling of materials possible.

The plant has its own powerhouse, furnishing both alternating and direct current for the operation of all mechanical devices. The power plant is equipped with three 350-horsepower Page Burton watertube boilers, arranged for either oil or coal burning, which develop somewhat over 1,400 indicated horsepower. Four steam-driven and two electrically-driven compressors furnish 6,000 cubic feet of free air per minute, maintaining a constant pressure of 100 pounds during working hours. Flow meters have been installed in the air machines, and by checking the number of pneumatic tools and appliances in use at peak load time, it is possible to compare the amount metered with the estimated required consumption. In case of any great variation the cause is immediately investigated, and air leaks and waste of air are brought down to a minimum. This method of controlling the air supply accounts in a great measure for the excellent records secured in the driving of rivets, the Pensacola yard exceeding all other yards in the Southern district in the number of good rivets driven per gang hour.

The fabricating and machine shops have all modern equipment, as shown by Fig. 6, and have capacities considerably in excess of the present requirements.

The Pensacola Shipbuilding Company is completing ten 9,000-ton deadweight capacity steel cargo ships, one of which is shown in Fig. 1. Six of these ships have been placed in service, and four of them have delivered their first cargo to Europe. The vessels are completed in every respect in the wet basin before being turned over to the operators, the average time required to install the machinery and complete the outfitting being 30 days.

Motorship *Katherine*, Converted from a Four-Masted Sailing Ship Into a Six-Masted, Bald-Headed Schooner, to Be Used as a Vegetable Oil Tanker

New Uses for Old Sailing Vessels

Former British-Built Schooner Katherine Converted into Motor Vegetable Oil Tanker for American Company

IN the development of the motorship many vessels that have not been economically successful in a former state have become of value commercially after the installation of Diesel or semi-Diesel oil engines. This fact was well demonstrated at the recent trials of the *Katherine*, the latest addition to the fleet of motor tankers, owned by the Philippine Vegetable Oil Company.

Tht *Katherine* was formerly a four-masted, square-rigged, iron sailing ship, but has been converted into a six-masted, bald-headed schooner for the purpose of taking advantage of favorable winds, although it is intended that her engines shall be the main source of power and run continuously when the vessel is on a voyage.

As converted, the principal dimensions are as follows:

Length overall	286 feet 9 inches
Length between perpendiculars	275 feet 0 inches
Breadth molded	43 feet 5 inches
Depth molded	24 feet 1 inch
Gross weight	2,196 tons
Net weight	2,087 tons
Engines	2 Bolinder fuel oil
Brake horsepower	640
Speed	8 knots

The hold of this vessel is divided into ten tanks, having a total oil capacity of 3,000 tons at a draft of 22 feet. An elaborate and efficient system of heating has been devised for regulating the temperature of the cargo, and by means of centrifugal pumps the tanks can be emptied in about ten hours. Two oil-fired Scotch marine boilers having a heating surface of 900 square feet and a working pressure of 150 pounds per square inch are installed for furnishing steam to the cargo-heating system and for supplying power to the pumping machinery.

In addition to the main pumping system the equipment includes a secondary drainage system of pumps to take care of oil below the suctions of the main plant. The entire cargo-pumping equipment, consisting of two duplex steam pumps, having cylinders 16 inches and 19½ inches diameter by 12 inches stroke, one auxiliary pump with cylinders 6 inches and 4 inches diameter by 4 inches stroke, one fire pump with cylinders 6 inches and 4 inches diameter by 6 inches stroke, is installed in the pumping room situated in the forward part of the ship between oil-tight bulkheads.

The main power plant, supplied by Messrs. Henry Lund

& Company, San Francisco, Cal., consists of two 320-brake-horsepower fuel oil engines of the latest Bolinder type, fitted with air injectors and special oiling systems, which contain an arrangement for saving and filtering waste lubricating oil. The auxiliary machinery includes one 25-brake-horsepower stationary type fuel oil engine running at 375 revolutions per minute and directly coupled to a 15-kilowatt generator and on the opposite end of the shaft through a clutch coupling to a two-stage air compressor, which is used for supplying air to the main engines in case of accident to the main compressor. A 15-brake-horsepower engine running at 450 revolutions per minute is directly connected to a 10-kilowatt generator, while a third, an 8-horsepower engine running at 550 revolutions per minute, is connected to a 5-kilowatt generator. All generators operate at 110-125 volts. An electric steering gear, supplied by the Herzog Electric Company, San Francisco, Cal., is fitted.

The main bilge and circulating pumps are driven from the forward end of the crankshaft of each engine. Auxiliary pumping machinery consists of one 4-inch by 6-inch triplex electrically driven pump with suctions to the sea as well as to the bilge; one electrically driven 6½-inch by 8-inch triplex pump for fire and bilge service, as well as for emptying and filling cofferdams directly connected to a 20 horsepower motor; one 3-inch by 4-inch electrically driven sanitary pump directly connected to a 3-horsepower motor.

Arrangement of Fuel Oil Tanks

Fuel oil tanks having a capacity of 2,200 barrels, sufficient for one hundred days' running, are carried in the double bottom under the pump room and aft of the engine room. In the forward part of the engine room two circular day tanks, each holding 26 barrels, are placed together with two circular tanks for storing 3,000 gallons of lubricating oil. The latter are connected through filters to the lubricating day tanks.

In addition to other equipment, the *Katherine* is fitted with a complete refrigerating plant, consisting of one motor-driven Jarvis ice machine having a capacity of 1¼ tons per day and nearly 1,000 feet of refrigerating space for ship's stores. The vessel has 20,000 cubic feet of dry cargo space besides the space in the hold occupied by the oil tanks. To handle supplies of a bulk character, four winches are provided. A complete wireless outfit having a range of 3,000 miles is also installed.

Accommodation is provided for the captain and officers in the aft part of the ship, while the crew is quartered forward.

Acceptance Trials of the Katherine

After alterations on the ship had been completed at the Hanlon Dry Dock & Shipbuilding Company's plant, Oakland, Cal., under the supervision of D. W. and R. Z. Dickie, naval architects, San Francisco, Cal., the *Katherine* proceeded to San Francisco Bay, where several runs were made over a measured mile course. The results of the trials showed that running with the tide an average speed of 9.06 knots was maintained, while against the tide the ship was able to average 7.02 knots, or a combined average of slightly over 8 knots. During the trial the ship was fully loaded, the cargo tanks having been filled, giving a draft forward of 20 feet 2 inches and aft 20 feet.

Shipbuilding in Canada.—Canada's shipbuilding industry, according to *Commerce Reports,* now employs about 25,000 men, while approximately another 25,000 are engaged in the manufacture of marine equipment and supplies. It is claimed by the same authority that the industry represents an investment of about $50,000,000 of capital, and that more than 90 percent of this progress has been achieved within the last four or five years. The Dominion Government has already appropriated about $70,000,000 for shipbuilding and some further appropriations are said to be under consideration. There is discussion of the expediency of giving out contracts for steel freighters and passenger ships for the National Merchant Marine, to be bonused on the basis of $10 per ton for all steel ships built in Canada that conform to certain standards of construction. The Government has also offered to aid wooden shipbuilding in British Columbia by loaning 75 percent of the capital cost of vessels built there.

Ship Surgeons Operate on the Avalon

REHABILITATED from a vessel minus bow and stern to a veritable floating palace, the steamship *Avalon,* owned by William Wrigley and associates, recently left the Brooklyn, N. Y., yards of the Morse Dry Dock and Repair Company, to pass through the Panama Canal; and thence to the waters of the Pacific. Plying between San Pedro and the Santa Catalina Islands, this ship will aid in the development of the city of Avalon and the Santa Catalina Islands, upon which Mr. Wrigley and associates have developed and sold more than a million dollars' worth of property.

Bespeaking the wonderful skill of modern ship surgeons, the *Avalon* with her stem and stern grafted to their natural places has been transformed from a battle-scarred appearance to a thing of beauty with two dance halls, de luxe cabins and woodwork costly and resplendent and so arranged as to obscure all inside piping and wiring. Since the signing of the armistice, when the United States Government halted work on her, this vessel has acquired, in addition to her wonderful appointments, her normal length, which had been reduced by 40 feet in the process of amputating her at bow and stern.

Once in the process of conversion as a United States troop transport to be known as the *Blue Ridge,* plying in the submarine infested waters between Calais, France, and Dover, England, the *Avalon* will now carry California visitors and excursionists between San Pedro and the City of Avalon, and, though ultra-fashionable in dress, she will be quite democratic in spirit, carrying anything from a milliner's hat box to a player-piano for a Santa Catalina bungalow.

A sturdy, well-preserved ship, the *Avalon* was coveted by the Government during its war-time need of tonnage. She was then in the vicinity of Chicago. The demand for tonnage became more and more urgent and the Government decided to send her to Boston for conversion.

To make this trip, the *Avalon* was required to pass through the locks of the Lachine canal, above Montreal. As the vessel was 277 feet 8 inches long and the locks of the canal did not permit a boat of this size to pass without closing its yawning gates, she was sent to a Chicago shipyards, where her length was reduced.

The severed plates of bow and stern were placed in the forward part of the ship and, surprising as it may seem, the *Avalon* proceeded to Boston under her own steam. In that city, the din and noise of riveters' guns ceased with the boom of European artillery and Mr. Wrigley and others purchased her from the Government.

She was towed from Boston to the Brooklyn, N. Y. yards of the Morse company, where her rehabilitation, even to a fuel oil-burning system, has been made so complete. The *Avalon* has a passenger-carrying capacity of 2,000, and is capable of a speed of 22 knots.

Fig. 1.—S. S. *Avalon*, After Being Lengthened 40 Feet and Fitted Out for Passenger Service on the Pacific Coast

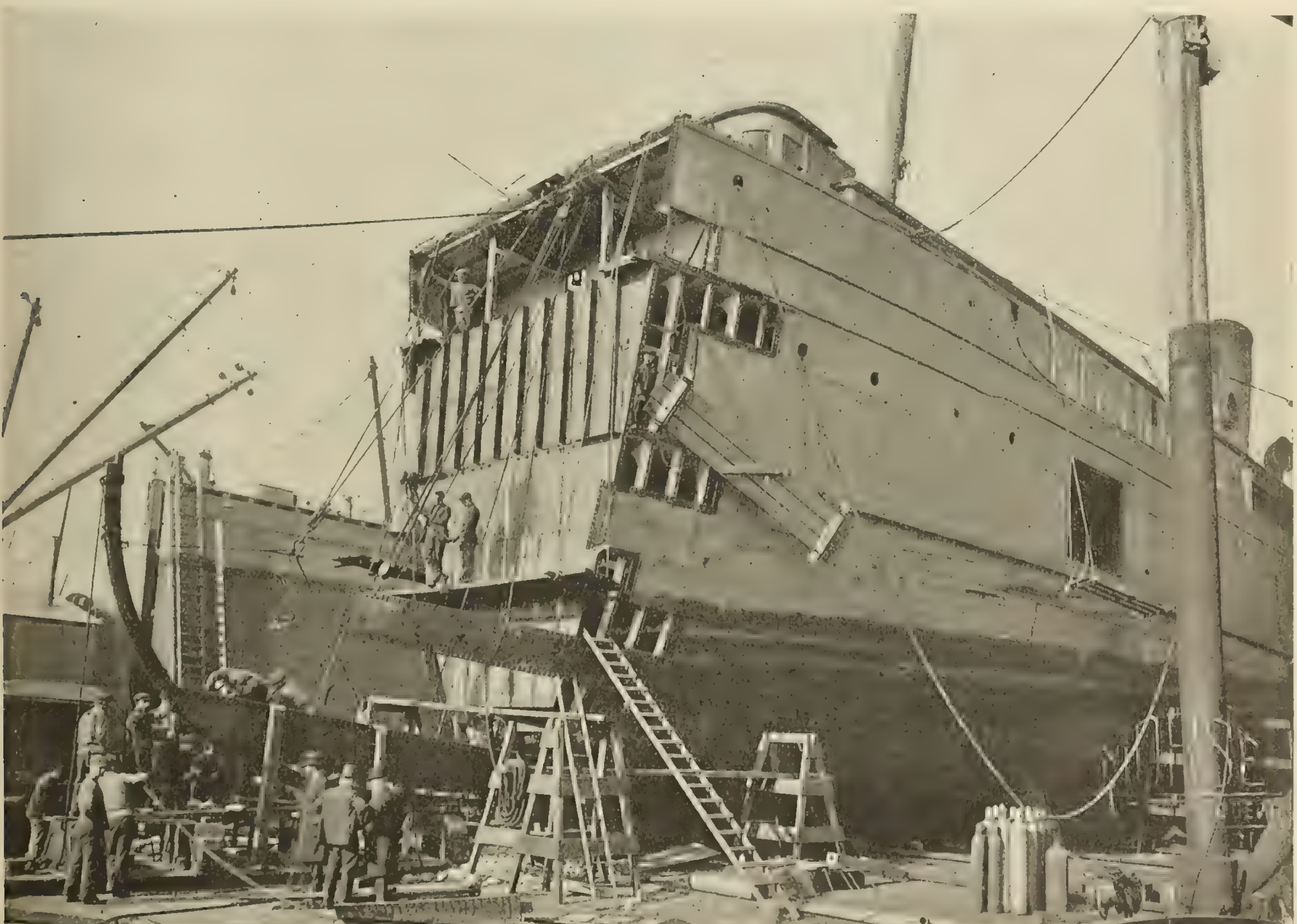


Fig. 2.—Restoring the Bow of the *Avalon* in One of the Dry Docks of the Morse Dry Dock & Repair Company

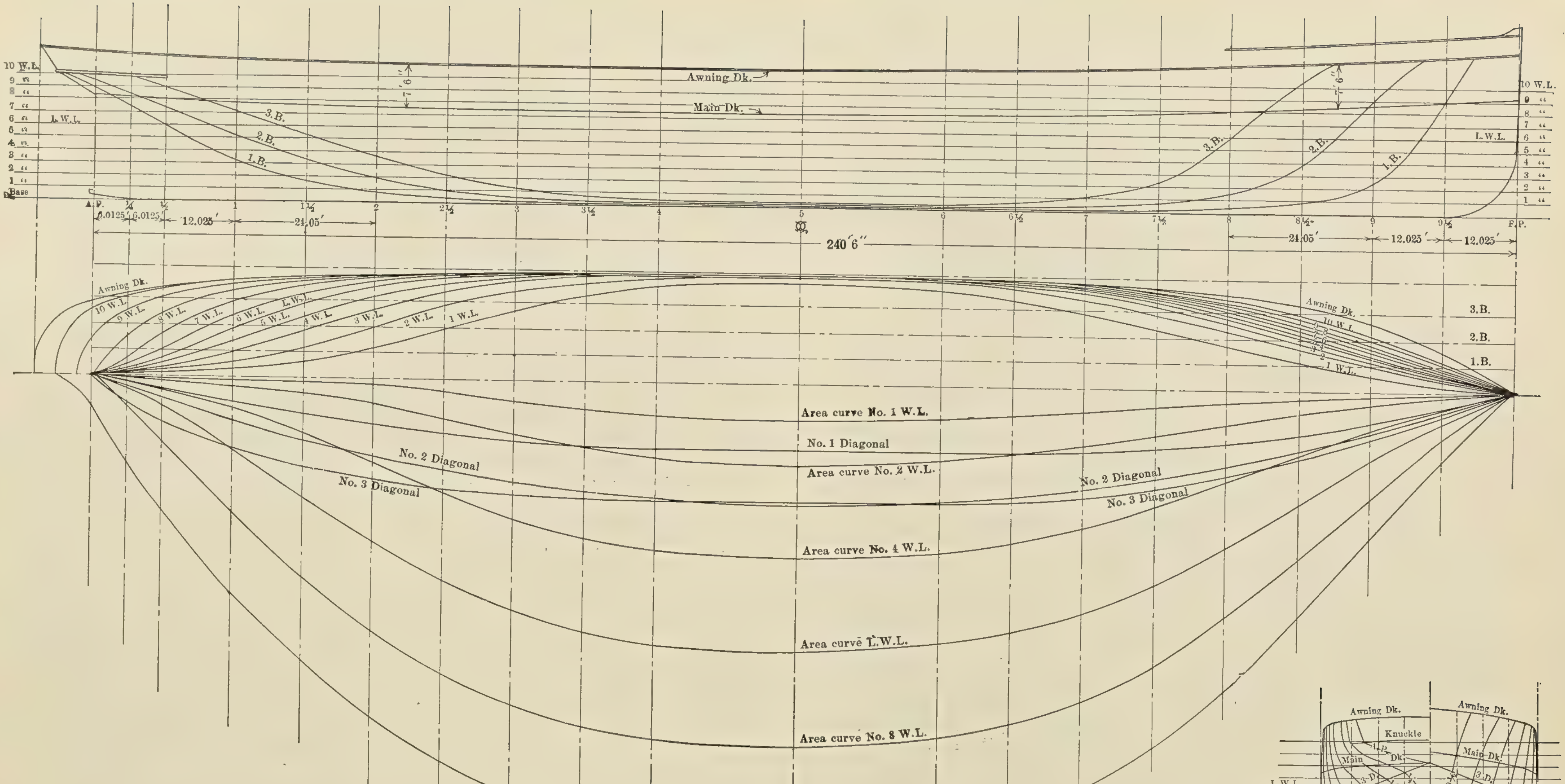


Fig. 1.—Lines of Twin-Screw Steel Passenger Steamer (Length, 240 Feet 6 Inches; Breadth, 37 Feet 3 Inches; Depth, Molded, 16 Feet), Designed for Union Steamship Company, Vancouver, B. C.

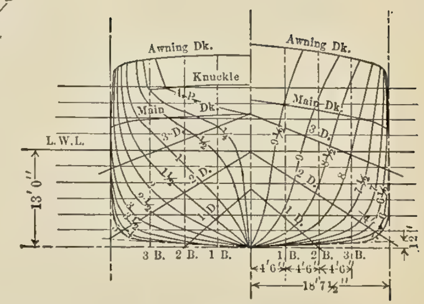


Fig. 2.—Body Plan

TWIN-SCREW PASSENGER COASTWISE STEAMER

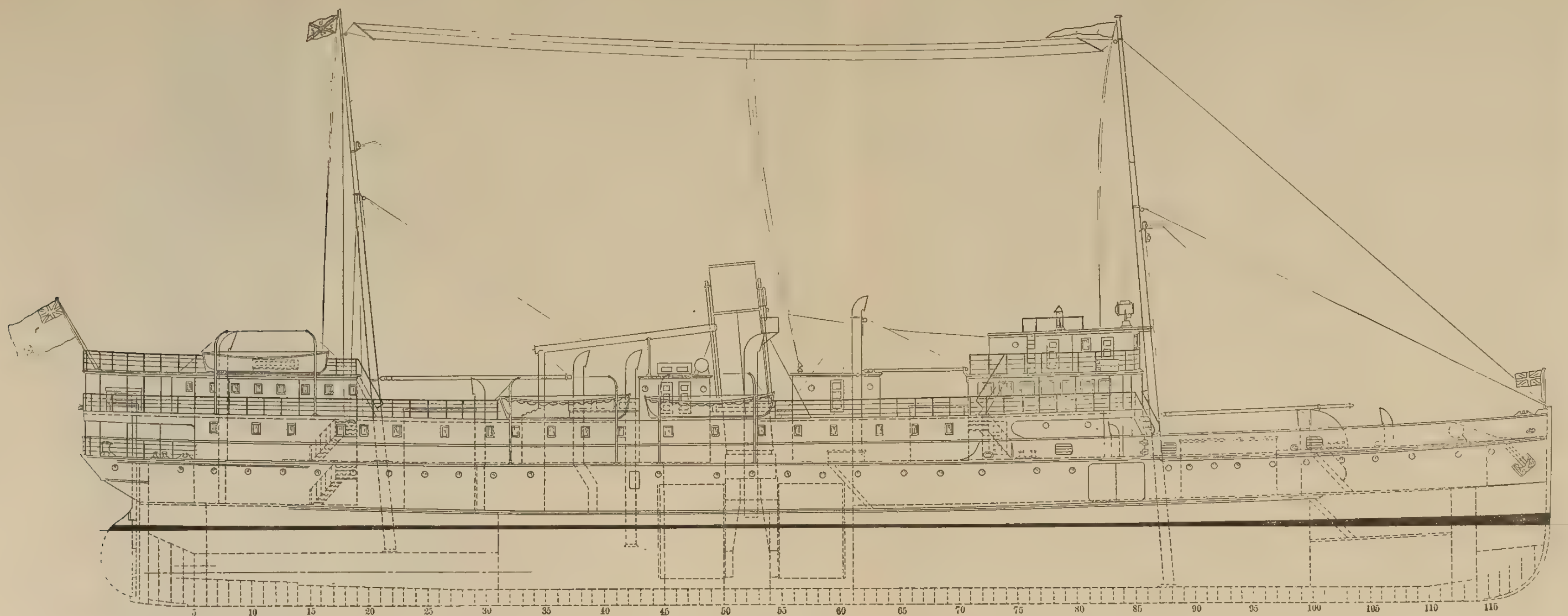


Fig. 3.—Outboard Profile

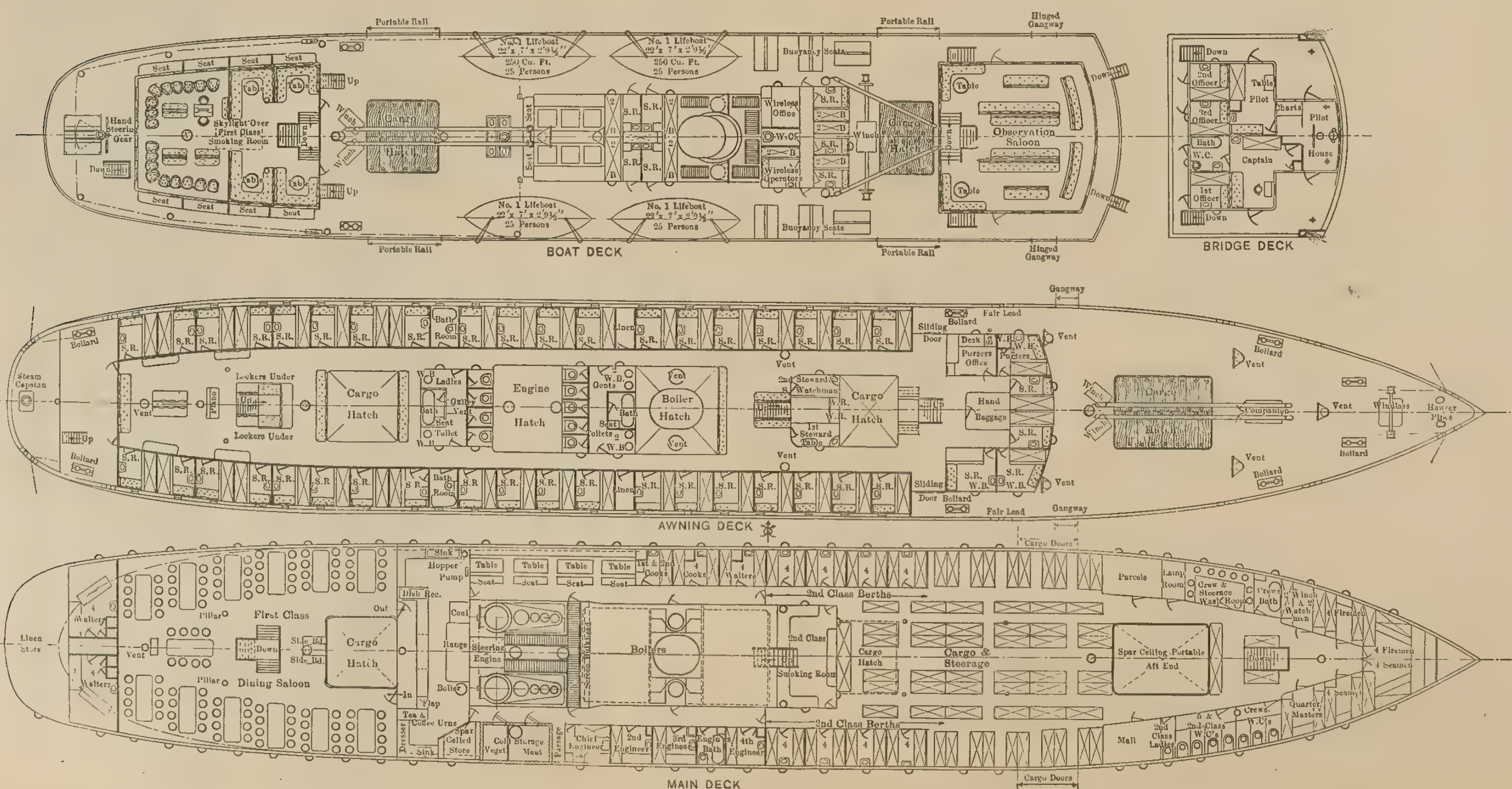


Fig. 4.—Deck Plans

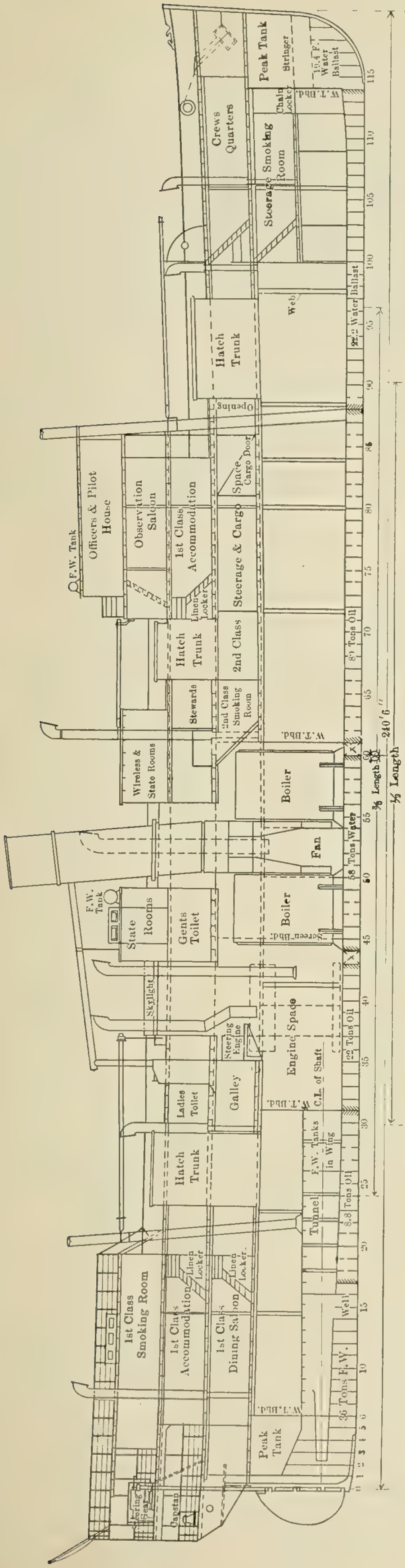


Fig. 5.—Inboard Profile

Twin-Screw Coastwise Passenger Steamer

Plans for 16-Knot Vessel of 2,000 Tons Displacement With Accommodations for 330 Passengers

TENDERS for the construction of a twin-screw steel passenger and cargo steamer of about 2,000 tons displacement and 16 knots' speed, designed by Henry Darling, consulting engineer and naval architect, Vancouver, B. C., are being asked by the Union Steamship Company of British Columbia, Ltd., Vancouver, B. C. The vessel is intended for service on the northern coast route between Vancouver and Prince Rupert. The design, as shown in the accompanying plans, calls for a vessel of the following dimensions:

Length overall	251 feet 6 inches
Length between perpendiculars	240 feet 6 inches
Beam, molded	37 feet 3 inches
Depth, molded	16 feet
Depth to awning deck	23 feet 6 inches
Draft, mean load	13 feet
Displacement to molded lines	2,012 tons
Block coefficient	0.604
Area of load waterline plane	6,819 square feet
Coefficient of load waterline plane	0.76
Area of midship section	457 square feet
Coefficient of midship section	0.945
Tons per inch immersion	16.15
Distance of center of buoyancy aft or No. 5 ordinate	5 inches
Indicated horsepower	2,800
Speed	16 knots

The vessel is to be built with a cellular double bottom to British Corporation rules for the highest class. Accommodations will be provided for 98 first class, 32 second

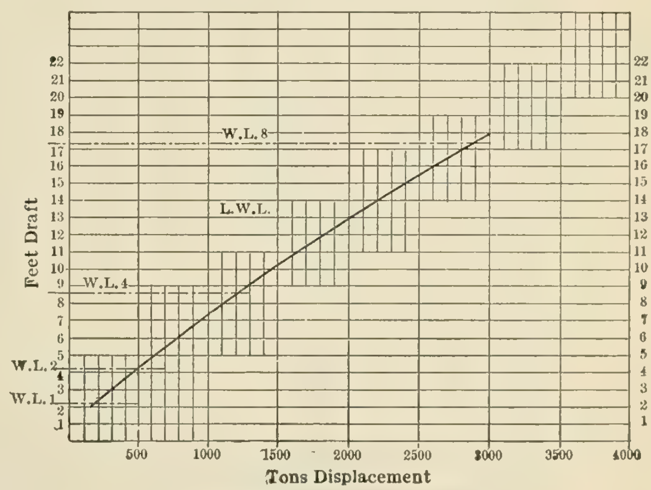


Fig. 6.—Displacement Curve

class, and 56 officers and crew in staterooms and cabins; and also, for 200 steerage passengers in portable berths. Special provision will be made for all sanitary fittings throughout, hot and cold water being supplied to all accommodations. The vessel will have a large cold storage room and a well-arranged galley, capable of meeting the needs of 150 passengers at one sitting. The vessel will be heated with steam and lighted with electricity.

Quarters for the captain and officers are on the bridge. A large first-class smoking room and an observation saloon are located on the boat deck. The first-class staterooms are on the boat and awning decks. The dining room, second-class mess room, cabins and smoking room are on the main deck. The engineers, petty officers and crew are berthed on the main deck, while the steerage berths are also on the main deck with the smoking room on the lower deck.

Cargo will be handled through three hatches, by means of steam winches and derricks capable of lifting three tons each. The vessel will be fitted with a steam windlass, steam steering gear, steam capstans, repeating telegraphs for operating and docking the vessel and all modern appliances for navigation, and the handling of cargo.

Propulsion will be by twin screws actuated by either triple expansion reciprocating engines or double reduction geared turbines capable of developing 2,800 indicated horsepower, which, it is estimated, will give the vessel a speed of 16 knots. Steam will be supplied at a pressure of 185 pounds per square inch, by two Scotch boilers 16 feet in diameter by 11 feet 6 inches long, each having four Morison corrugated furnaces. The boilers will be fitted with Howden's patent heated forced draft and for oil fuel burning, the furnaces being fitted with Coen's patent oil burners.

All of the auxiliaries will be independent, consisting of Weir's uniflux condenser, air and feed pumps, a centrifugal circulating pump with engine, a Lamont's auxiliary feed and general service duplex pump; an Ellison's pulsometer, besides a fresh water duplex and sanitary duplex pump. There will also be an Edmiston feed water filter and a Weir's surface feed heater. The electric plant will consist of twin sets of combined vertical engine and generator capable of supplying 40 kilowatts at 110 volts.

The vessel will be equipped with six lifeboats, six buoyant seats, six life rafts, one small boat and a suitable number of life buoys and preservers for 500 persons.

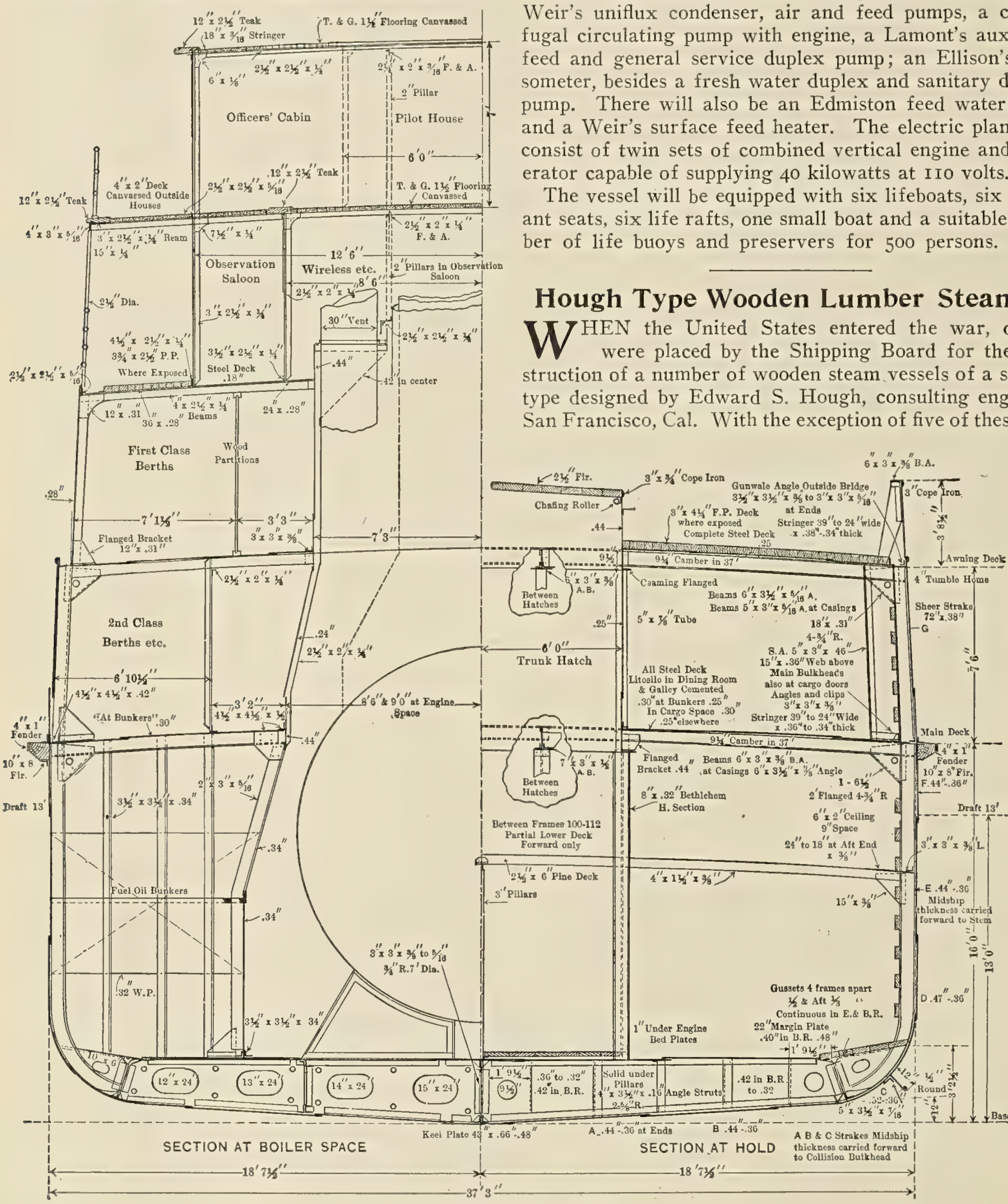


Fig. 7.—Midship Section

Hough Type Wooden Lumber Steamer

When the United States entered the war, orders were placed by the Shipping Board for the construction of a number of wooden steam vessels of a special type designed by Edward S. Hough, consulting engineer, San Francisco, Cal. With the exception of five of these vessels, which were unfinished at the time of the signing of the armistice, all of them have been in service at sea and at the present time are trading all over the world. One of the unfinished vessels, the *Anson S. Brooks,* has been converted, as shown in the accompanying plans, to meet the requirements of the lumber trade on the Atlantic Coast and West Indies, with return cargoes of sugar or other commodities. Duplicates of this vessel have been running and are still operating very largely in the general cargo trade to the Hawaiian Islands, bringing back sugar and fruit.

In converting the *Anson S. Brooks* into a lumber car-

rier, all of the 'tween-deck accommodations were eliminated, allowing, with the space gained by fitting oil fuel in place of coal, a considerable addition in cargo space and a consequent increase in deadweight capacity. These vessels were designed for a deadweight of 3,500 tons, but have carried up to 3,990 tons. The *Anson S. Brooks* will carry up to 1,750 M feet of lumber and, with her oil tanks filled for fourteen days' steaming, will draw 21 feet of water. The principal dimensions of the vessel are as follows:

Length overall	286 feet
Beam, over planking	46 feet
Depth, molded	28 feet
Draft, loaded	21 feet
Indicated horsepower	1,400

Propulsion is by two vertical triple expansion engines with cylinders 15½ inches, 26 inches and 44 inches diameter by 26 inches stroke, which develop 700 indicated horsepower each. Steam is supplied by two standard Shipping Board type watertube boilers with a total heating surface of 5,036 square feet. The main condenser has a cooling surface of 2,002 square feet.

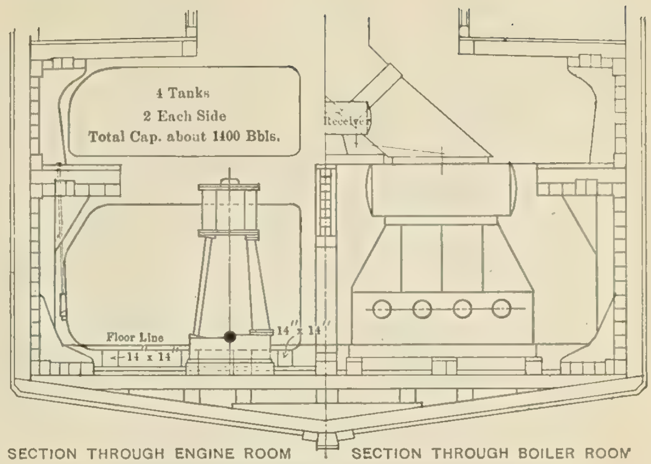


Fig. 2.—Sections Through Machinery Space

Provision is made for carrying 89 tons of fresh water and 1,440 barrels of fuel oil.

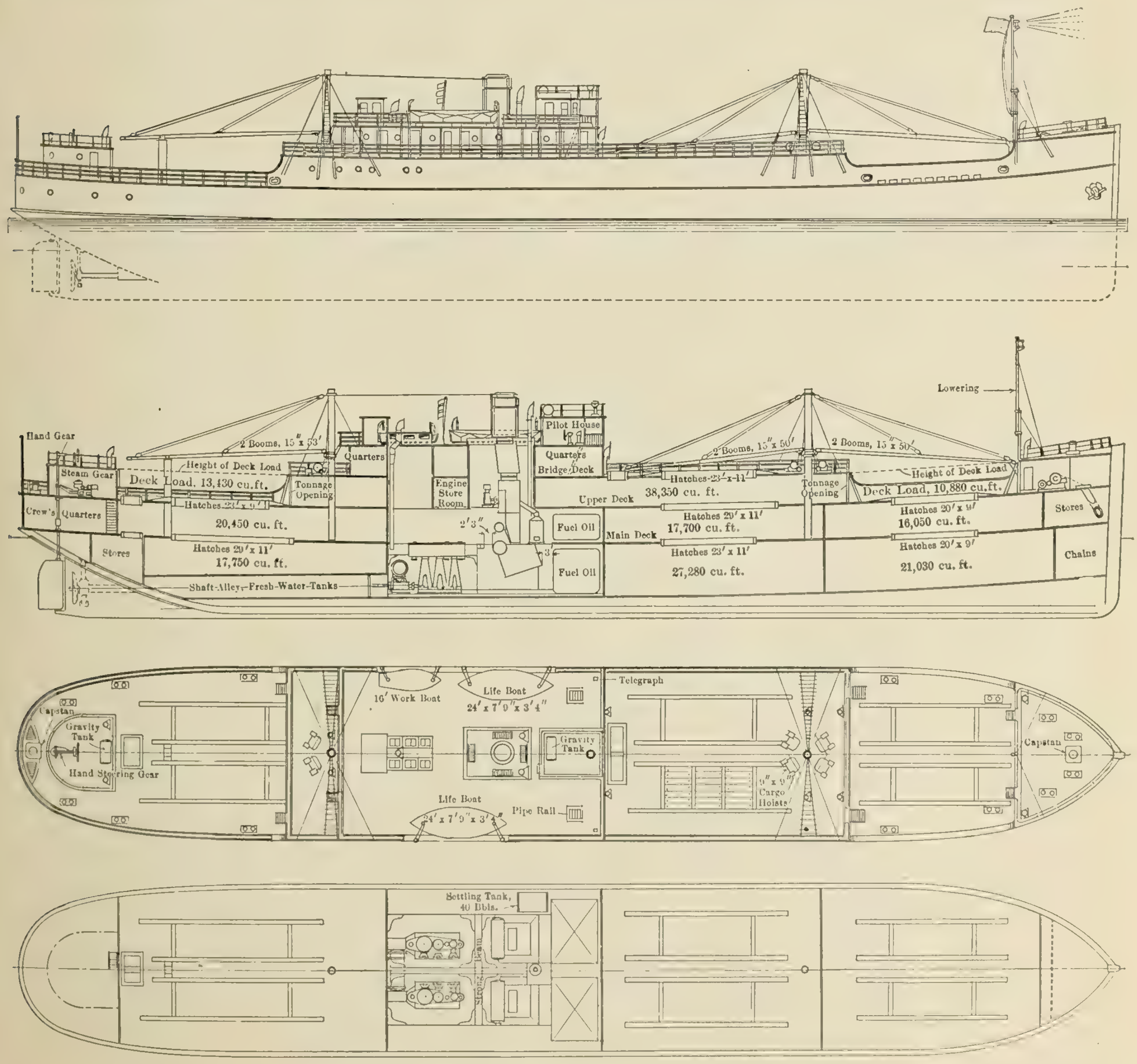


Fig. 1.—General Plans of Hough Type Wooden Lumber Steamer

The cargo capacities of the various holds are as follows:

	Cubic Feet
No. 1 hold	21,030
No. 1 'tween decks	16,050
No. 2 hold	27,280
No. 2 'tween decks	17,700
No. 3 hold	17,750
No. 3 'tween decks	20,450
Upper 'tween decks	38,350
Deck load, forward	10,880
Deck load, aft	13,430
Total	182,920

The capacities given above are measured inside the line of the web frames. For bulk cargo the space between the web frames, amounting to 12,710 cubic feet, must be added, giving a total capacity of 195,630 cubic feet.

Electric Welding at Submarine Boat Yard

ELECTRIC welding is, as stated in a recent issue of *Speed Up* by W. L. Prince, superintendent of the welding department of the Submarine Boat Corporation, Newark, N. J., very essential in all great metal construction; and although it has long been in common use in other industries, its application to shipbuilding has been largely confined to repair work and to the welding of minor parts when failure would not be fatal to the safety of the ship. Its great worth having been proven, however, it is now used almost exclusively throughout the construction of the fabricated ships.

Early in February, 1918, the first electric welding machine was installed in the south shops for the purpose of welding water- and oil-tight frames. This, however, was but a beginning, for before a great length of time had expired between 500 and 600 operations were being performed by electric welding, and at the present time fifty-seven welding machines are in use throughout the plant.

The welding done now by acetylene is nothing in comparison to its usage formerly. Acetylene cutting is a great aid in the building of ships, as it enables the erectors and shipfitters to lay up the steel correctly, and all other workers as well. We have about eighty skilled mechanics who may be called upon at any time to either cut or weld.

Werf Gusto Launches 6,200-Ton Freighter

WERF GUSTO, Firma A. F. Smulders, Schiedam, Holland, launched on March 16 the steel cargo steamer *Ellewoutsdyk* for Messrs. Solleveld, van der Meer and T. H. van Hattum's Steamship Company at Rotterdam. This is the second of four vessels of the same type which Werf Gusto is building for this company.

The steamer, which is being built under special survey to the highest class of Lloyds as a lumber carrier, is of the single-deck type with poop, long bridge and forecastle, with a carrying capacity of about 6,200 tons deadweight. The dimensions are as follows:

Length between perpendiculars	359 feet 3 inches
Breadth, molded	50 feet
Depth	24 feet 6 inches

Propulsion is by a surface condensing, triple-expansion engine of 1,800 indicated horsepower, giving the ship a speed of about 10 knots, steam being supplied at a working pressure of 180 pounds per square inch by three Scotch boilers with a heating surface of about 5,450 square feet. The vessel will be fitted with an electric generating set for lighting purposes, a steam anchor and steering gear and the necessary steam-cargo winches.

Immediately after the launching, the keel was laid for a ship of the shelter-deck type of 6,500 tons deadweight destined for the same shipowners.

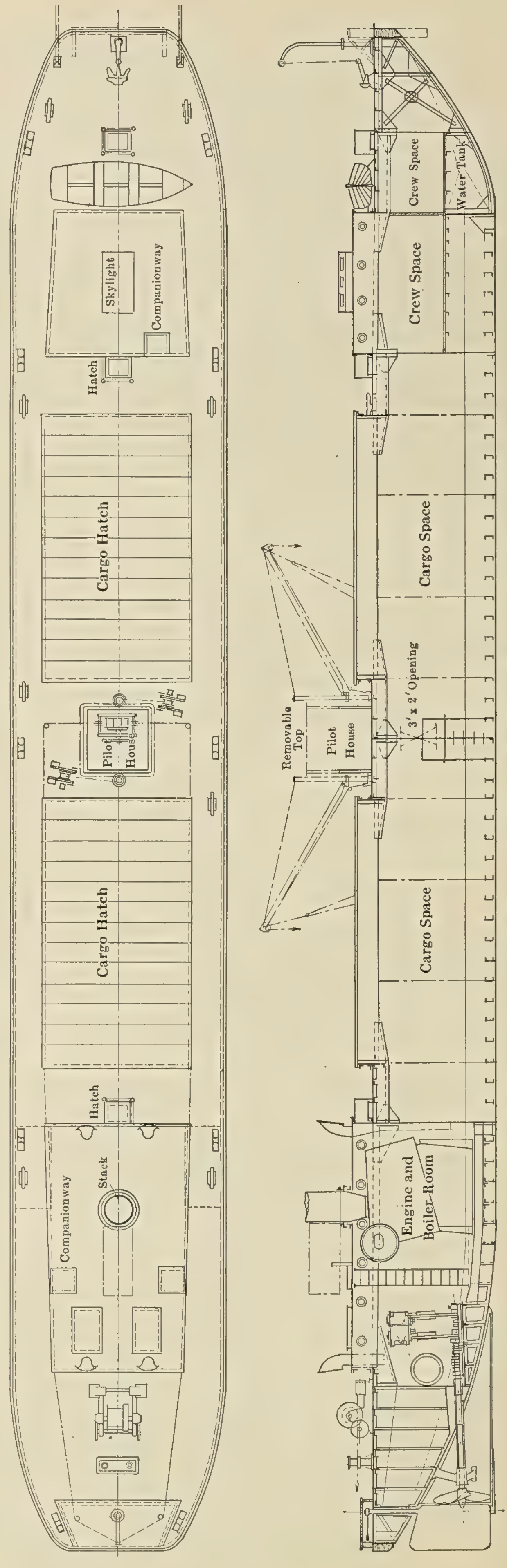


Fig. 1.—General Arrangement Plans of Self-Propelled Steel Barge for New York Barge Canal

Fig. 2.—Launching of 150-Foot Steel Barge for New York Canal System

Steel Barges for the New York Barge Canal

Vessels 150 Feet Long Have Deadweight Cargo Carrying Capacity of 550 Tons—Contain Three Holds, Served by Large Hatches

FIFTY-ONE steel barges, each 150 feet long, designed by Cox and Stevens, naval architects, New York, are now under construction for service on the New York State Barge Canal. In addition to these, a number of similar barges with propelling machinery are being built, all of the barges being constructed under the supervision of Cox and Stevens, the designers.

The principal dimensions of the barges are as follows:

Length, inside fenders	150	feet
Beam, molded	20	feet
Depth	12	feet
Draft, light, forward	27½	feet
Draft, light, aft	30	feet
Displacement, light	155	tons
Displacement on 9-foot draft	705	tons
Deadweight cargo	550	tons

The hulls are square ended with rounded ends, as shown on plans. There is a slight shear at the ends to take up the camber of the beams. The bilge is cut away, as shown on the midship section.

The barges are divided into five compartments by four watertight transverse bulkheads, and have three cargo holds with two hatches for each hold. The ends are hung from the end bulkheads by lattice girders, as shown on plans.

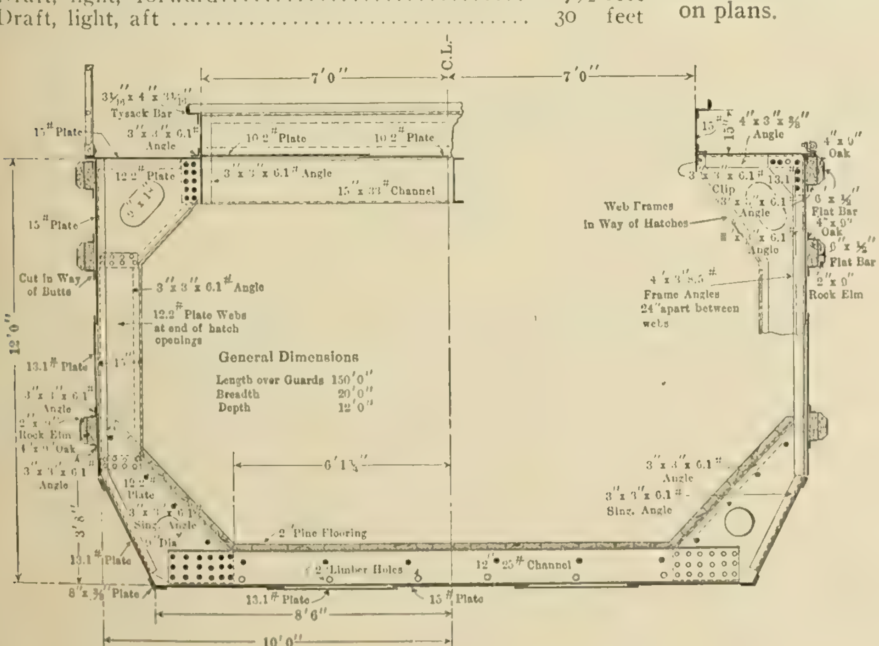


Fig. 3.—Midship Section of Barge

The accommodations for the crew are arranged for in a house at the after end of the barge. There is a skeg at the after end to which the rudder, operated by hand gear, is attached.

These barges are constructed throughout of steel, the details of the construction having been carefully developed so as to produce a light and serviceable hull. Especial attention is paid to the necessary protecting fenders, and the hull throughout is rigid and sufficiently strong to stand the usage to which these barges will be put.

The hatches, of which there are six in all, are as large as possible, being 14 feet wide by 10 feet in length, with coamings and tight covers. Ceiling of 2-inch pine is worked in the holds and carried up on the faces of the bilge brackets.

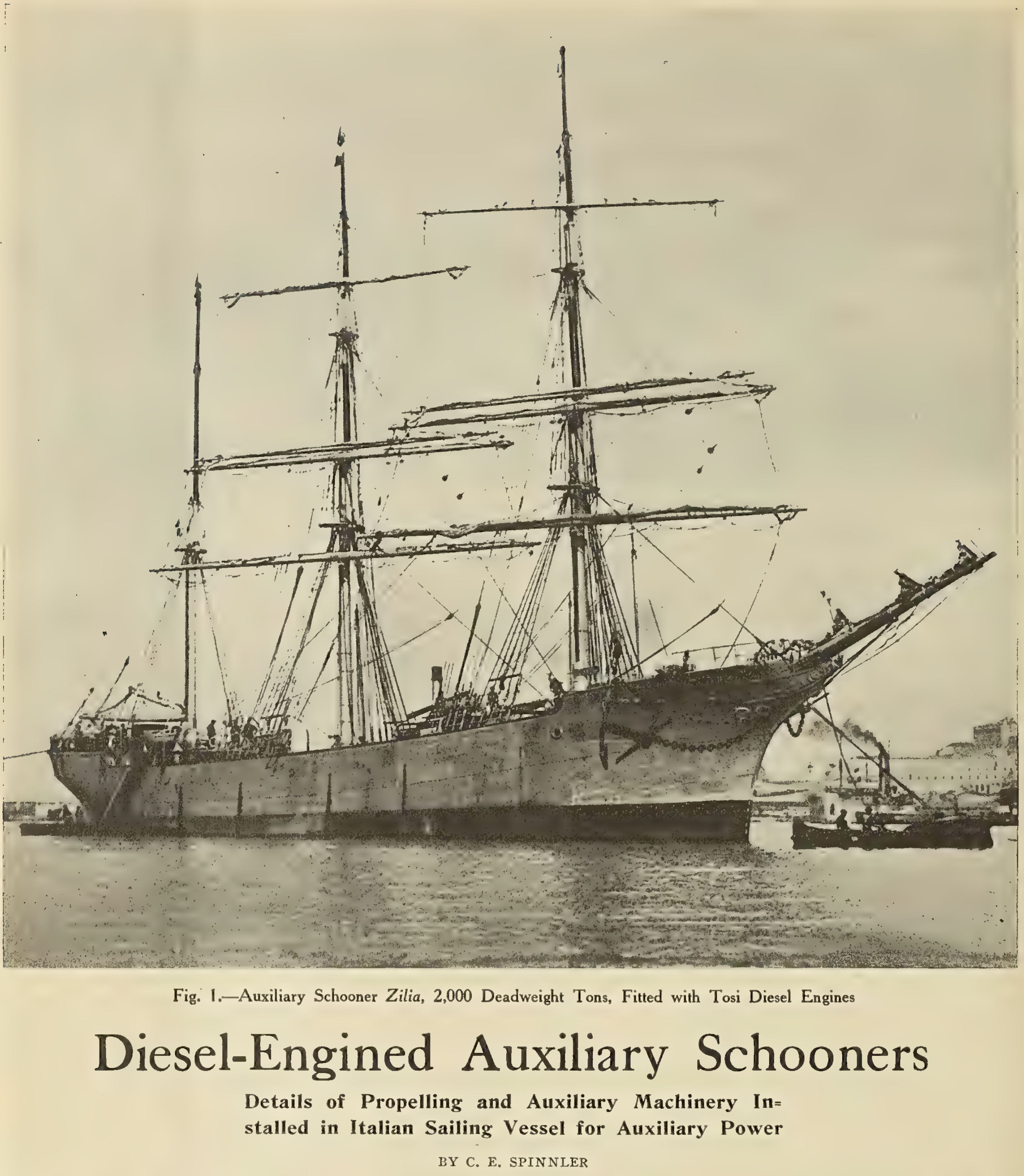


Fig. 1.—Auxiliary Schooner *Zilia,* 2,000 Deadweight Tons, Fitted with Tosi Diesel Engines

Diesel-Engined Auxiliary Schooners

Details of Propelling and Auxiliary Machinery Installed in Italian Sailing Vessel for Auxiliary Power

BY C. E. SPINNLER

DURING the war, owing to the acute shortage of tonnage, every available bottom was pressed into service. Especially was this true in European countries, which were hard hit and had to pay a very heavy toll to the submarines of the central powers; they were forced to make up their losses by putting into service old-fashioned sailing vessels, which in themselves were easy prey to the "sea-wolves" on account of their low speed and great visibility. To increase the speed of these sailing vessels and also to make them more independent of weather conditions, internal combustion engines were installed and are still now being placed in these hulls to great advantage, transforming the vessels into self-propelled cargo carriers.

In the beginning, many mistakes were made by putting incomplete and inadequate propelling machinery on board, or in other words underpowering the ship. These mistakes are gradually being eliminated, as practice has shown that a vessel for high-sea trade should have sufficient propelling power to give a speed of at least 8-9 knots in calm weather, or under all circumstances when sails cannot be used. I know of instances when 30-year old sailing vessels have made, with favorable wind, 16 to 17 knots for several days with sails alone.

In England, France and Italy old-steel sailing vessels have continually been so converted into auxiliaries. The English schooners *Circe Shell, Midway, Hornshell, Fennia* and *Oweenee* have, during 1918-1919, been provided

DIESEL-ENGINED AUXILIARY SCHOONERS

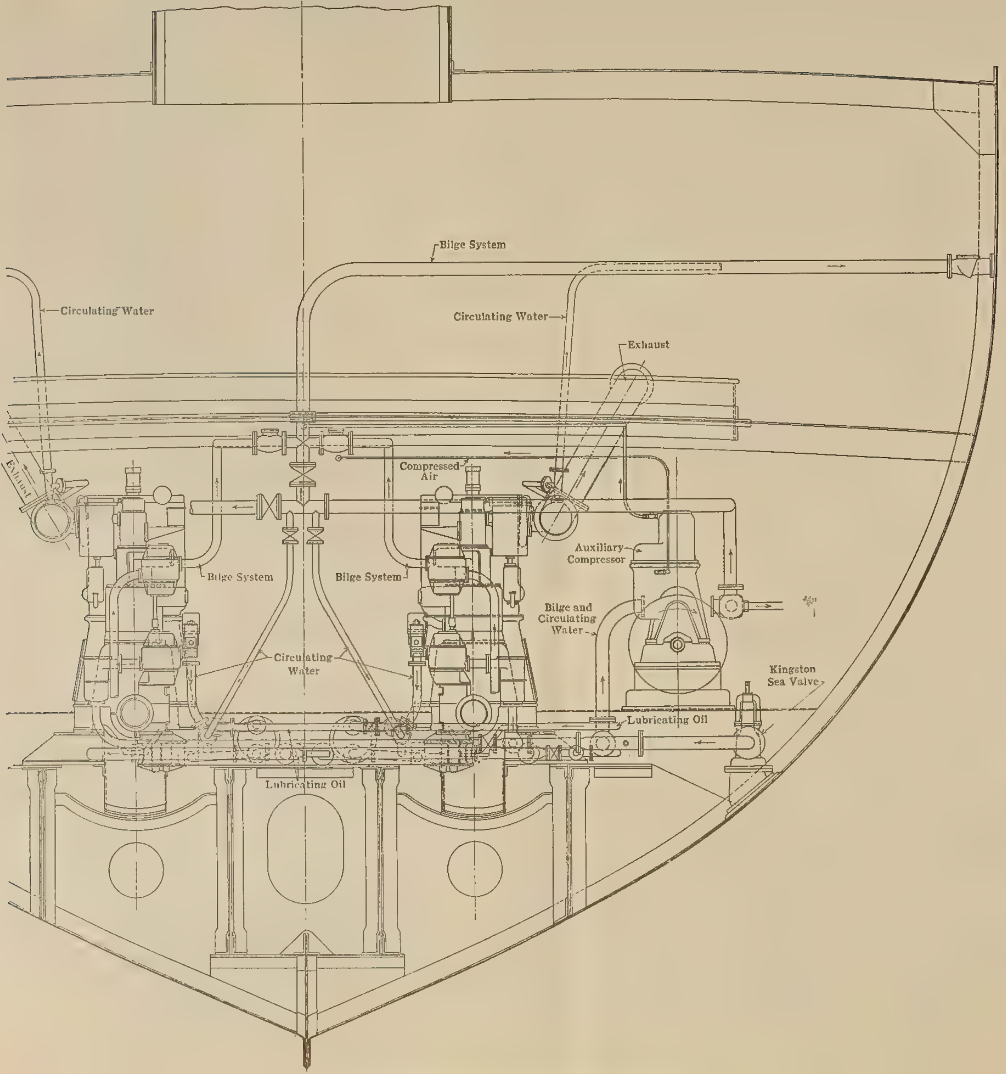


Fig. 2.—Transverse Section at Frame 28, Looking Forward

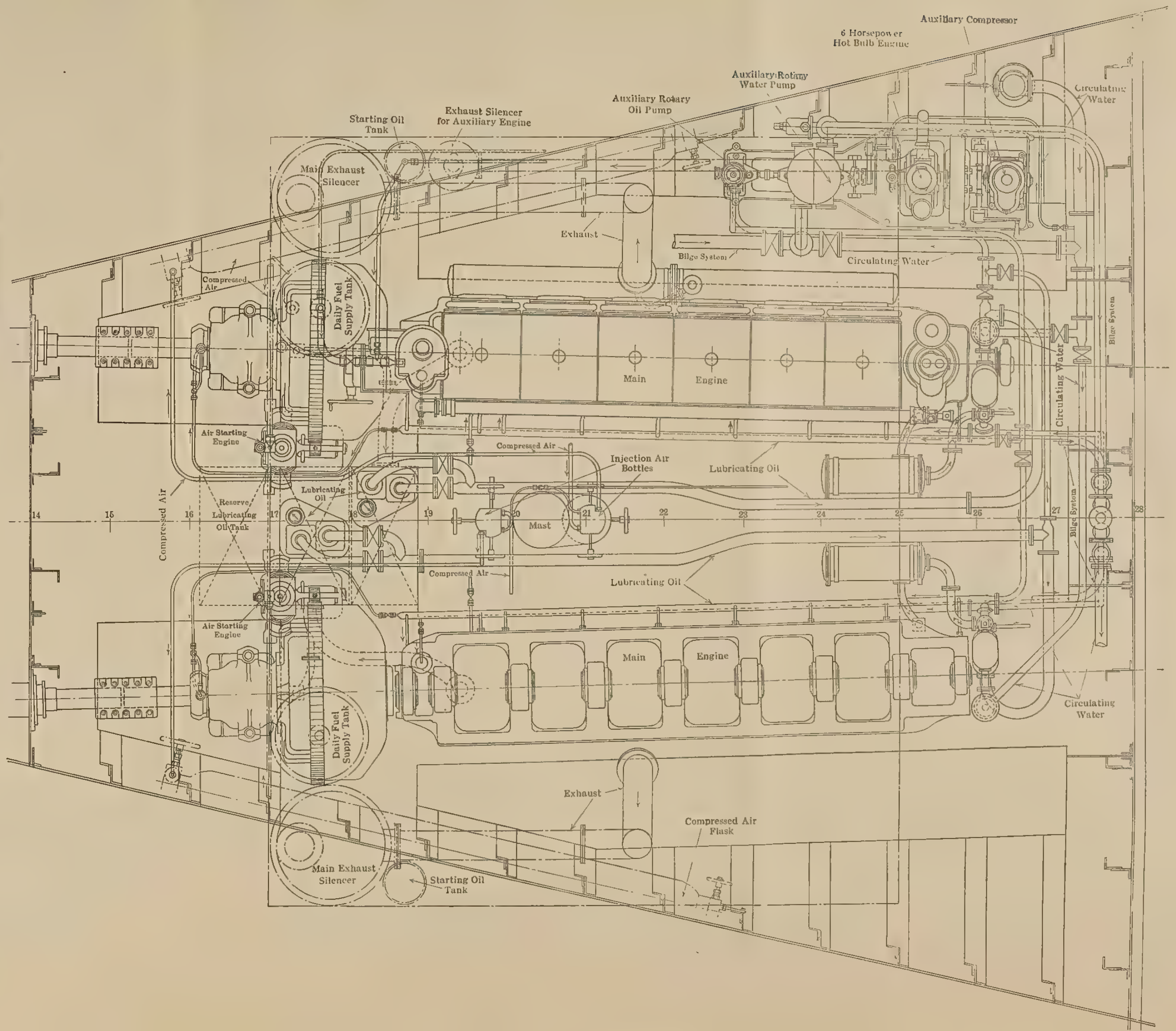


Fig. 3.—General Layout of Tosi Diesel Engines in the *Zulia*

DIESEL-ENGINED AUXILIARY SCHOONERS

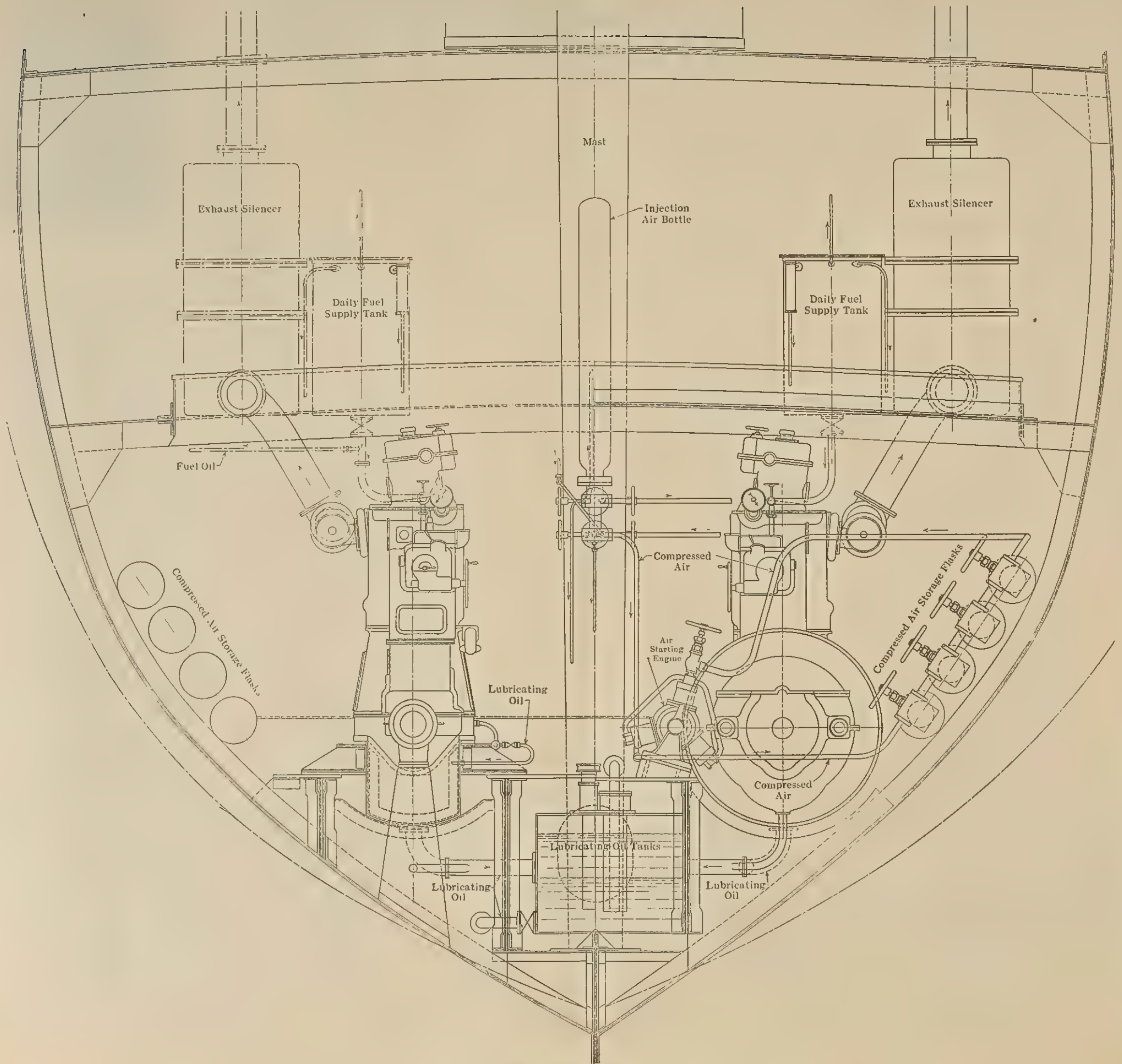


Fig. 4.—Transverse Section Through Engine Room, Looking Aft

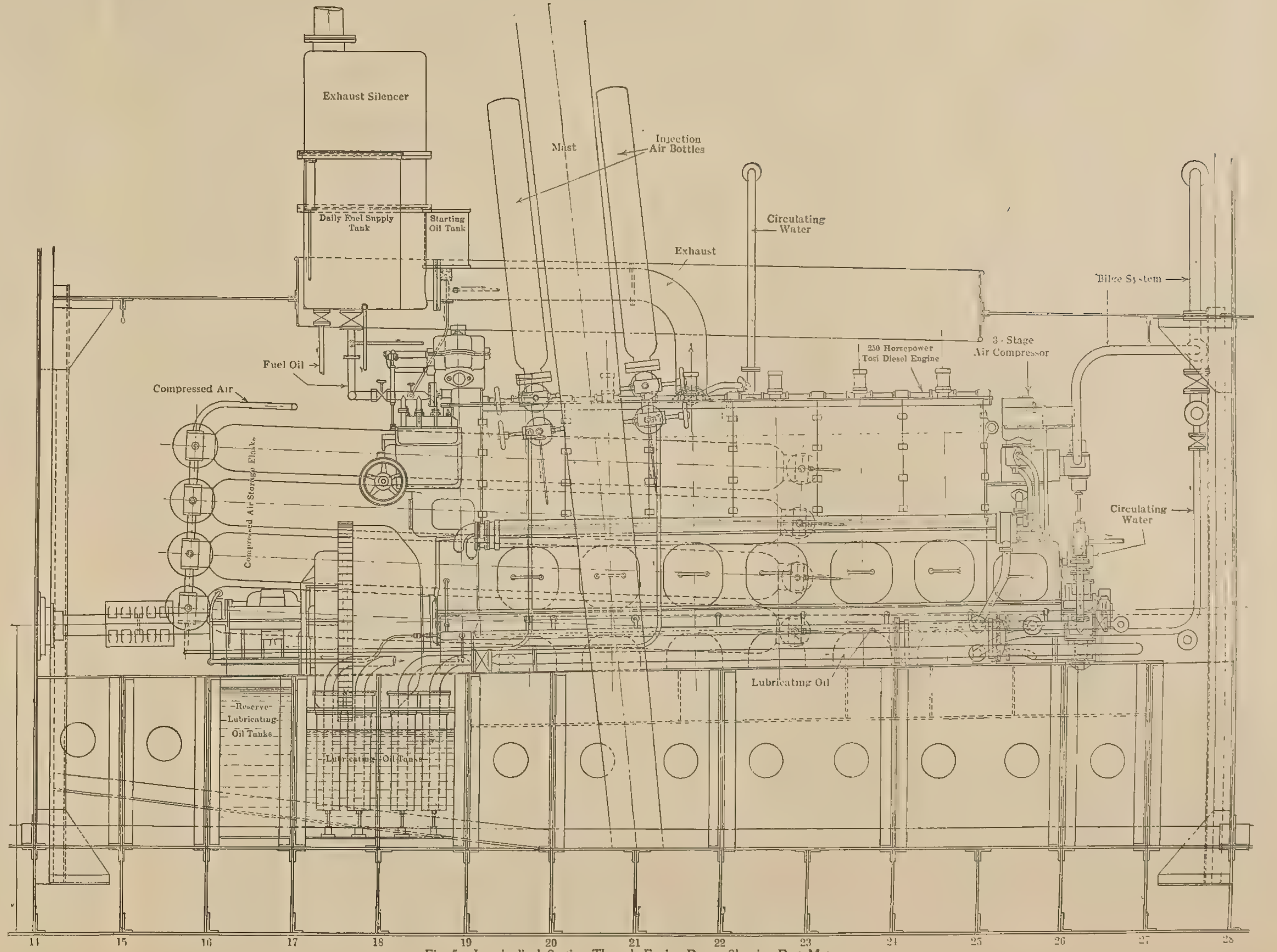


Fig. 5.—Longitudinal Section Through Engine Room, Showing Port Motor

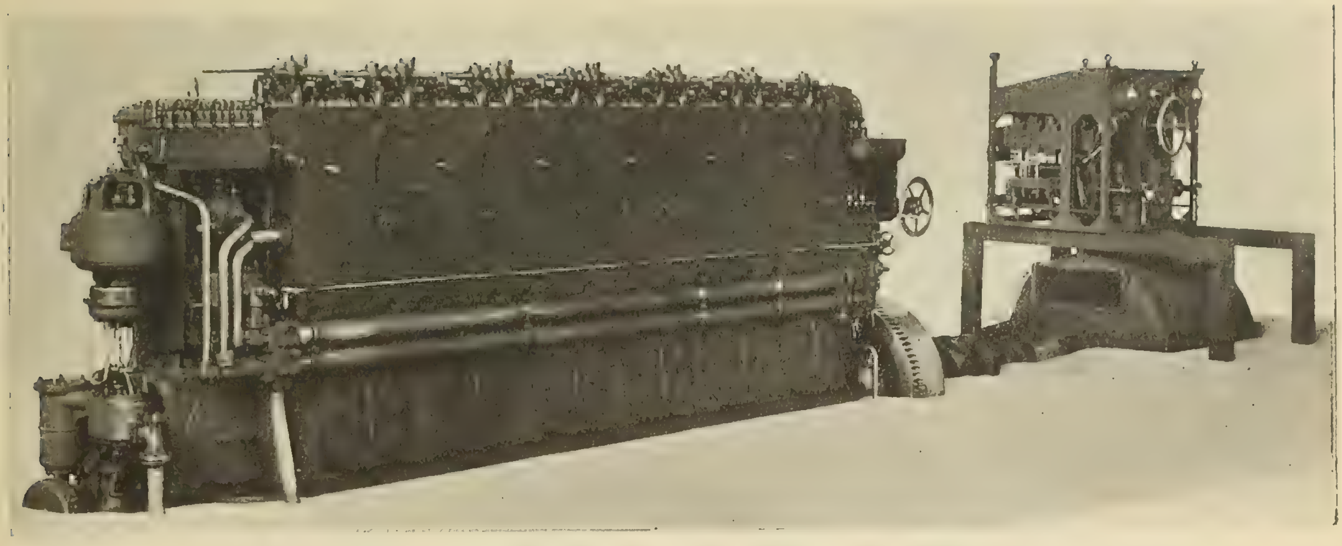


Fig. 6.—General View of Tosi Six-Cylinder Diesel Engine

with Vickers submarine engines of 1200-1300-horsepower, which give these vessels a speed of 9-9½ knots loaded. In Italy also, many good old-steel sailing vessels have been fitted with auxiliary power, to comply with a law passed by Parliament through the efforts of the Seamen's Association, which provides that no sailing vessel be allowed in high-sea trade which is not equipped with auxiliary propelling machinery. In Italy as well as in England, a great number of submarine engines have been and are still available, ranging in sizes from 300-horsepower per engine up to 1200-1300-horsepower.

Italian Auxiliary Sailing Vessel

The first Italian schooner provided with such an engine was the *A. S. Olona,* of the Lloyd Mediteraneo, Livorno. The engine on this boat is of the 2-cycle, 6-cylinder, 1300-horespower type. The rated horsepower as an auxiliary engine is 550 at a speed of 150 revolutions per minute. A second engine of the same type will be installed in another sailing vessel of the same company.

The success of such installations depends in no small degree upon how these engines are installed and, in the writer's estimation, very often insufficient consideration is given to the matter of a proper foundation for the engine itself and to the general arrangement of the main engine and auxiliaries. More careful study and greater consideration are required for the installation of such auxiliary engines on board existing sailing vessels than in new construction, and many mistakes, which apparently have been overlooked during the transformation, have in many instances unnecessarily burdened the owner with excessive expenditures for repairs, and also been the cause of the undermining of the reputation of the internal combustion engines as marine engines.

The latest additions to such converted sailing vessels are several Italian auxiliaries fitted with Tosi Diesel engines of the submarine type, as well as of the Crosshead type.

The sailing vessel *Zilia* of 2,000 deadweight tons, built in 1892, owned by the Soc. Stella d'Italia, of Genoa (see Fig. 1) has been converted to auxiliary power by the installation of two six-cylinder four-cycle Tosi trunk piston engines having cylinders with a diameter of 12-3/16 inches, and a stroke of 14¼ inches each, developing 250 horsepower each at 260 revolutions per minute. Each engine is connected to its propeller shaft by means of a friction clutch.

The dimensions of the vessel are:

Length	236 feet
Beam	34.2 feet
Depth	20.8 feet

From the plan (Fig. 3) it will be seen that the engines are installed right aft in the vessel. Each engine has a 3-stage injection air compressor placed at its forward end.

Starting Engine

These engines are directly reversible and are started by means of a small separate starting air engine, turning the flywheel by means of a spur gear, similar to the method used to start automobile and boat engines with electric starters.

Each starting engine consists of three single acting cylinders arranged around the crankshaft, each cylinder 120 degrees apart from the other (see Fig. 7), that it is

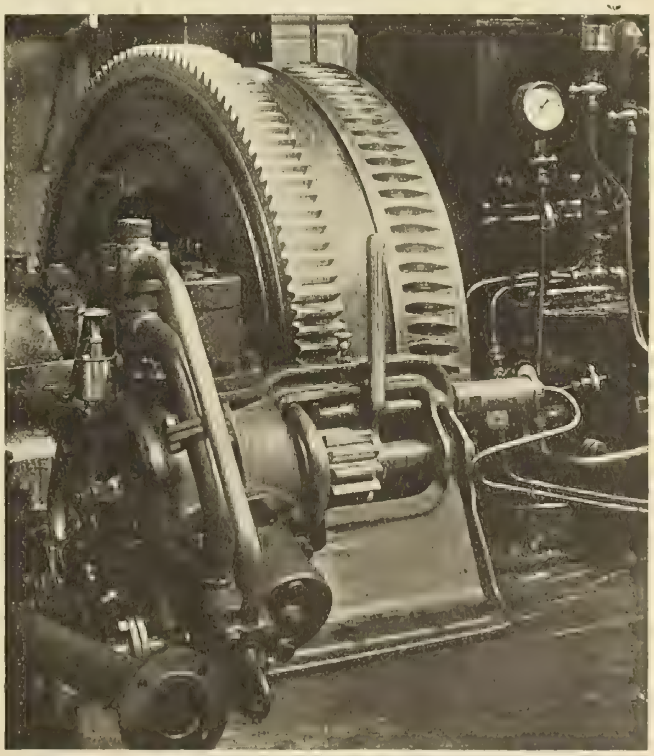


Fig. 7.—Air Starting Engine

Fig. 8.—Italian Submarine, Fitted with Tosi Diesel Engines

possible to start the engine at any position. The starting engine pinion is drawn in and out from the flywheel gear automatically by an air control.

Machinery Arrangement

The arrangement of the pumps and other auxiliaries can be seen from the engine room layout (see Fig. 3). The engine room itself is roomy and well ventilated, and all the piping is so disposed as to permit a quick inspection and easy cleaning.

Each engine has four compressed air-storage steel flasks of a total capacity of 38 cubic feet air, at a pressure of about 1,000 to 1,200 pounds per square inch maximum. Their capacity is sufficient to start and reverse the engine for quite a number of times without recharging from the auxiliary compressor; during maneuvering, however, this little compressor is continuously in operation to keep the starting air pressure at the necessary height to insure quick air service. For the injection air one flask of 1.7 cubic feet capacity is provided for each engine with an air pressure of 1,000-1,200 pounds per square inch maximum. During operation a pressure of about 925 pounds per square inch is maintained.

The storage air flasks are arranged outboard of each engine, whereas the injection air bottles are fastened upside down to the aft mast and are provided with the necessary control valves. Each bottle is provided with a drain valve for water and oil.

All the bottles can be charged from either the main compressors or from the auxiliary compressor.

Fuel Oil Service

Each engine has its own service tank of a capacity of about 100 gallons. These tanks are provided with strainers, indicators and overflows and are fed by means of a fuel supply pump which pumps the fuel from the main tanks of these service tanks. From these tanks the fuel oil flows direct to the fuel injection pumps of each engine.

These fuel tanks are arranged as near as possible to the exhaust silencer at the aft end of the engine room on a gallery, so as to heat up the fuel oil to make it flow better through the piping to the fuel injection pumps.

A small light oil tank is also provided for each engine to start the engines more easily in cold weather.

Lubrication

Forced lubrication is provided for all parts of the engines such as crankshaft bearings, crank pins, and wrist pins.

The lubricating oil is sucked by the oil circulating pumps from the lubricating oil tanks, which are located in the bilge between the main engines, and driven through coolers from which it enters a header which runs inboard alongside of each engine. In connection with each crankshaft bearing a small feed line deviates from the header and in the usual way the oil is pressed through grooves in the bearings and holes in the crankshaft pins, webs and crankpins to the crankpin bearing and from here through the hollow connecting rod to the piston pin and bearing.

The oil is re-collected in the engine bilge and flows from here to the settling tanks which are of about 100-gallon capacity each. Each settling tank is provided with a double strainer and oil stand indicator. The strainers are easily removable for cleaning purposes during service.

The whole lubricating system is very well shown in the

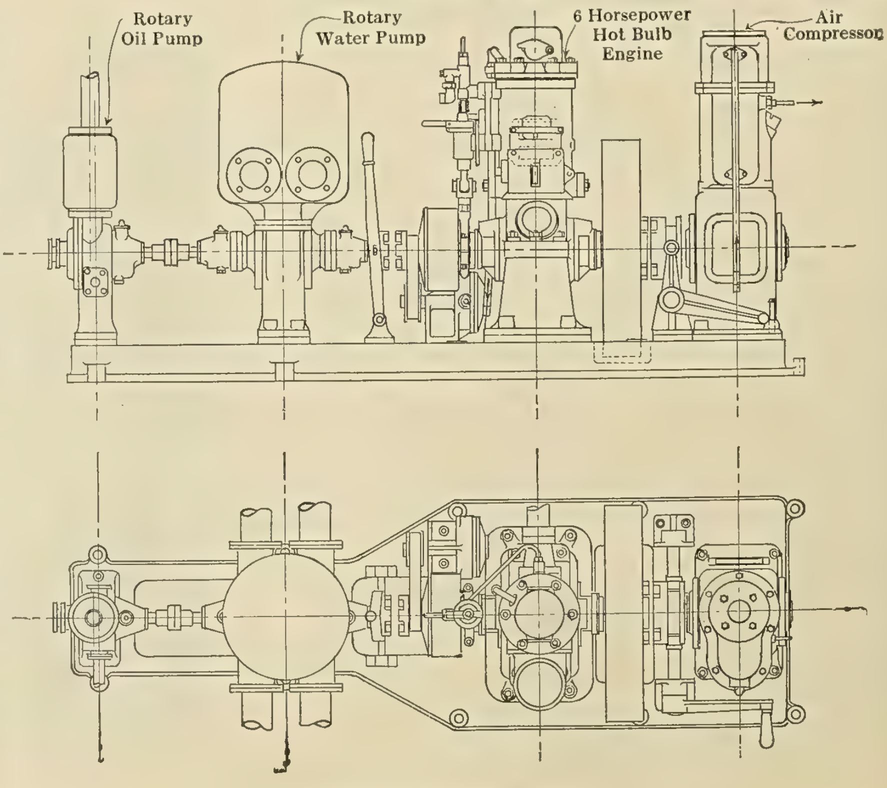


Fig. 9.—Tosi Auxiliary Set

engine room layout, Fig. 3. Aft of the settling tanks a reserve lubricating oil tank is arranged, with capacity of about 125 gallons.

Engine Room Auxiliaries

Among the auxiliaries there is a small combined compressor and pump set, composed of one 6-horsepower hot bulb oil engine running at 500 revolutions per minute, and driving on one side by means of a claw-clutch a 3-stage air compressor of suitable size to fill in a relatively short time the starting air and injection air bottles, at a pressure of 1,000-1,200 pounds per square inch. On the other side there is a group of one rotary auxiliary water pump and one rotary auxiliary oil-circulating pump. Both pumps are of sufficient size to supply the engine-cooling water and circulating oil for one engine, in case that the main pumps driven by the main engines should get out of order (see Fig. 9).

The guaranteed fuel consumption for these engines, combined with the auxiliaries, is 2.5 tons per 24 hours, and the lubricating oil consumption is also very low on account of the forced lubrication system used, amounting to about 3 grams per horsepower-hour.

All the main pumps, i. e., the water and oil-circulating pumps, are driven direct from the main engines. One set is large enough to supply the circulating water and oil for both engines at somewhat reduced speed.

From information received, the whole propelling machinery has given very satisfactory results and many other sailing vessels are being provided with similar power plants, varying in capacity from 500 to 750 and 1200-horsepower, at propeller speeds of from 260 to 165 revolutions per minute.

Weight of Machinery

The weight of the main engines, including the auxiliary set, air storage bottles, fuel oil and lubricating oil tanks and exhaust silencer, without, however, the friction clutch, thrust bearing and shaft lines, is about 36 tons or about 160 pounds per shaft horsepower. The whole installation, comprising engines, friction clutch, thrust bearing and shaft lines, should weigh no more than 50-55 tons, resulting in a weight of 220-245 pounds per shaft horsepower.

Deck Auxiliaries

Several steam winches and a steam windlass have been placed on deck. A small oil-fired donkey boiler has been installed amidships on deck, the funnel of which can be seen on the photograph of the vessel shown in Fig. 1.

The writer has no information about the installation of an electric generating set, and it seems quite unbelievable that the installation of such a generating set has been omitted, as electric light on board ships is now-a-days quite as essential as fresh water.

Fig. 8 shows one of the smaller Italian submarines which have been built during the war, and which have been provided with engines of the same size and type as above described. From reports it appears that these engines have given complete satisfaction in actual service as regards both workmanship and performance.

Hudson River Steamboat Mary Powell

BY TOWNSEND J. SMITH*

It will be of interest to many to learn that the famous old Hudson River sidewheel steamer Mary Powell is finally to be sold to the ship-breaker, thereby ending a long career of usefulness. This vessel has been unique in that through a period of about fifty-five consecutive seasons of service, no serious accident ever occurred, and no passenger or member of the crew was ever killed.

BUILT at Jersey City, N. J., in 1861 by Michael Allison, the *Mary Powell* went into service in 1862, running on the Hudson River between Rondout and New York City, making about eight intermediate landings and doing the round trip daily, except Sundays, the distance totalling about 190 miles per diem. This in itself is no great feat, but to the native along the river's banks the discontinuance of the service will seem a real loss, as the boat had become an institution.

* Marine department, Standard Oil Company of New York.

Fig. 1.—S. S. *Mary Powell*, Famous Steamboat in Service on the Hudson River for 68 Years

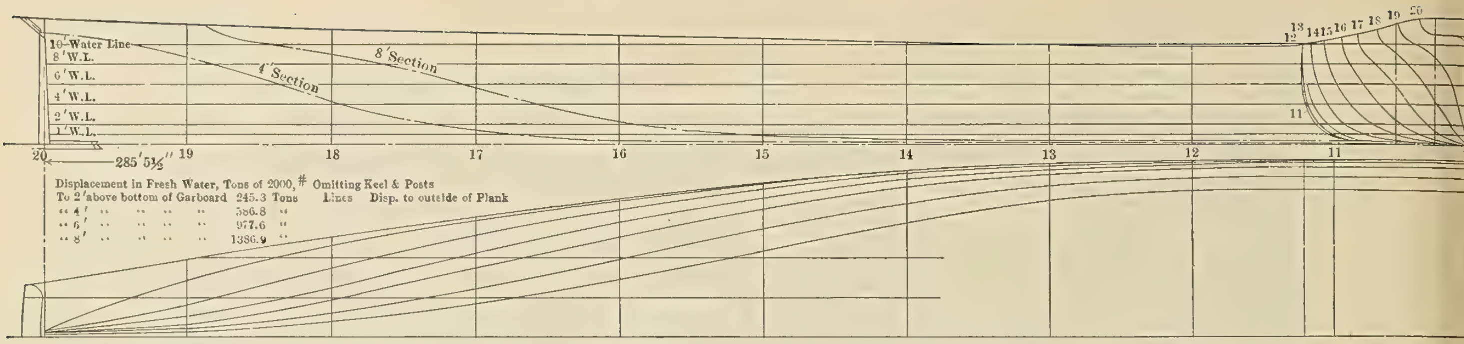


Fig. 2.—Waterlines and Body

Owing to changing river conditions, the present owners had come to feel that the boat's profitable days were over, but with a more than usual regard for sentiment had refused offers of various curio hunters who might have given the steamer an ignoble end, two of the conditions of the sale being that she was not to be burned, nor to be destroyed as part of a moving picture.

Built practically entirely from empirical design, data as to actual performance are lacking, except for the very ample figures supplied by the late chief engineer of the United States Navy, Admiral B. F. Isherwood, in the *Journal of the Franklin Institute* for July, 1879, from which some of the following facts are taken. The lines of the vessel, shown in Fig. 1, are authentic, having been drawn from offsets measured when the vessel was on dry dock in 1896. Structurally the vessel is of a type peculiar to the Hudson River, i. e., a shallow hull, kept in shape longitudinally by the "hog frame" truss construction of timbers about 12 inches by 14 inches, keyed together and extending from the keelson forward up through and over the joiner work decks, then down to the side keelsons at the after end, the sagging tendencies of the machinery weights being communicated to the truss timbers with vertical rods, diagonal rods leading to masts, one forward and four near the boilers, also being employed to distribute the strains.

The practice was to carry only enough coal for a day's run, or about 30 tons. The machinery with appurtenances, including water in the boiler, weighs about 210 tons, or with fuel about 27 percent of the load displacement. The boilers themselves were renewed at various times, the present ones having been built in 1904, but no change was made in the general design, which was of special tubular construction, with a superheating steam drum 90 inches diameter by 12 feet long, surrounding a chimney 50 inches diameter. The furnaces, two per boiler, measure 4 feet 9¾ inches by 8 feet long, giving a total of 154 square feet grate surface. The heating surface, estimated by Isherwood at 4,726 square feet, was later increased to 5,694 square feet.

These boilers are mounted on the guards (sponsons), the theory of the early builders being that a disaster was less likely to be serious if the boilers went overboard, rather than up through the deck, should an explosion occur.

The propelling machinery, built by Fletcher, Harrison & Company, predecessors of the present W. & A. Fletcher Company, Hoboken, N. J., is of relatively simple construction, the engine being of the single-cylinder, jet-condensing, walking-beam type, "the beam being supported upon a lofty triangular gallows frame of wood, very stiff and very light." The cylinder is of 72 inches diameter by 144 inches stroke, developing, in the trial referred to, 1,745 indicated horsepower at a consumption of 21.93 pounds of steam per hour, exclusive of steam used by the forced draft engine. Allowing 5 percent as the blower consumption of steam, 40,171 pounds of steam per hour were used and 6,050 pounds of anthracite coal, giving a water rate of 6.64 pounds of water per pound of coal and 39.3 pounds of coal per square foot of grate.

The air pump is of the vertical, single-acting type, 40 inches diameter by 62 inches stroke. The main cylinders and steam pipes from the boilers are heavily lagged with asbestos, but the valve chests, side pipes and cylinder heads are not lagged.

The two admission valves are set to cut off at about 48.6 percent of the stroke, the exhaust valve closing at 23.2 percent from the end of the stroke for cushioning effect. The lineal clearance of the piston is about 1⅝ inches.

The paddle wheels were never fitted with feathering floats, the old style of flat "buckets" being maintained to the end. The main particulars of the wheels were as follows:

Outside diameter	31 feet
Number of buckets per wheel	26
Revolutions per minute	21.8

At the time of the trial in 1877, when the boat was probably in what might be called average age and condition, the following were the results obtained as a mean of regular runs:

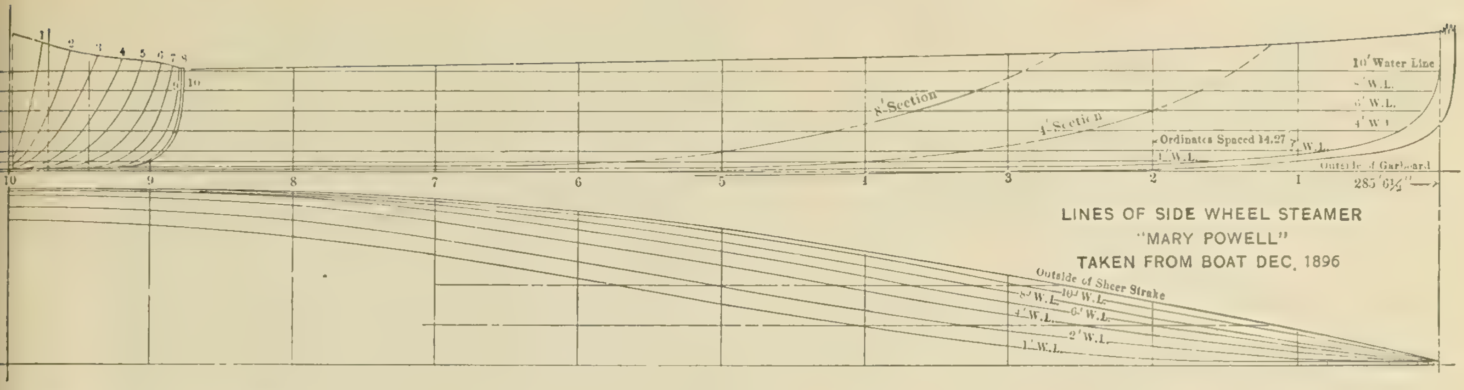
Expansion in cylinder	1.984
Temperature of injection water	68 degrees F.
Temperature of hot well	120 degrees F.
Air pressure in fan duct	1¼ inches
Steam pressure at commencement of stroke	41.4 pounds
Mean pressure	24.42 pounds
Speed in statute miles per hour	19.2
Speed in knots (of 6,080 feet) per hour	16.657
Apparent slip (center of pressure)	16.37 percent
Speed length ratio	.98

The fastest times actually on record for the steamer were made in 1882, when 25 miles were covered in one hour and one minute, and another in 1893, when the distance from New York to West Point, or 50 miles, was covered in two hours and five minutes.

Taken all in all, the whole life of this boat has been a success, and goes to show that the teachings of the rule of thumb and experience such as guided the building of this boat are never to be despised, especially in the realm of things maritime.

COEFFICIENTS OF LOAD WATERLINE IN TERMS OF BREADTHS—STEAMBOAT *MARY POWELL* (See Fig. 2)

Stem	.02	6	.99
½	.11	7	.91
1	.23	8	.66
2	.50	9	.29
3	.78	9½	.13
4	.96	Stern	.02
5	1.00		



Plan of the *Mary Powell*

Destroyers and Submarines Built by Swan, Hunter, and Wigham Richardson, Ltd.

FOLLOWING the programme of the British Admiralty to relieve private yards of warship construction and to give more work to the dockyards, H. M. S. *Whitehall,* a torpedo boat destroyer, has just left the Wallsend Shipyard of Messrs. Swan, Hunter, and Wigham Richardson, in an incomplete state. The ship is to be propelled by two screws driven by turbines built by The Parsons Marine Steam Turbine Company, Ltd., of Wallsend. The main engines, auxiliaries, piping, etc., have all been put on board, but final connections are not yet made. The bridge deckhouses are erected but not entirely finished, and the interior woodwork has still to be fitted. In the same way, the officers' quarters aft have not yet received their final embellishments. The ship's guns and torpedo tubes will also be installed by dockyard hands.

The *Whitehall* is the thirtieth destroyer built by Messrs. Swan, Hunter and Wigham Richardson, since the outbreak of the war. Her predecessors were H. M. S. *Wild Swan* and *Whitshed,* which are similar to the *"V"* class of destroyers which were commissioned two or three years ago. Of the latter class the *Vimiera, Violent* and *Vittoria,* followed by the *Whirlwind* and *Wrestler,* were built at the Wallsend shipyard. After these destroyers came the *"S"* class of which Messrs. Swan, Hunter and Wigham Richardson launched seven in 1918. These were followed by the improved *"W"* class of which examples are the *Whitshed, Wild Swan* and *Whitehall.* They carry more torpedo tubes and heavier guns than those of the earlier *"V"* and *"W"* class destroyers. Furthermore, the navigating bridge has been raised and various other modifications have been introduced.

The British Navy has also just received another useful addition in the shape of the submarine *L*.33, built and engined by Messrs. Swan, Hunter and Wigham Richardson, of Wallsend-on-Tyne. Before leaving the Tyne, the *L*.33 went through a series of trials both on the surface and submerged, which were carried out satisfactorily.

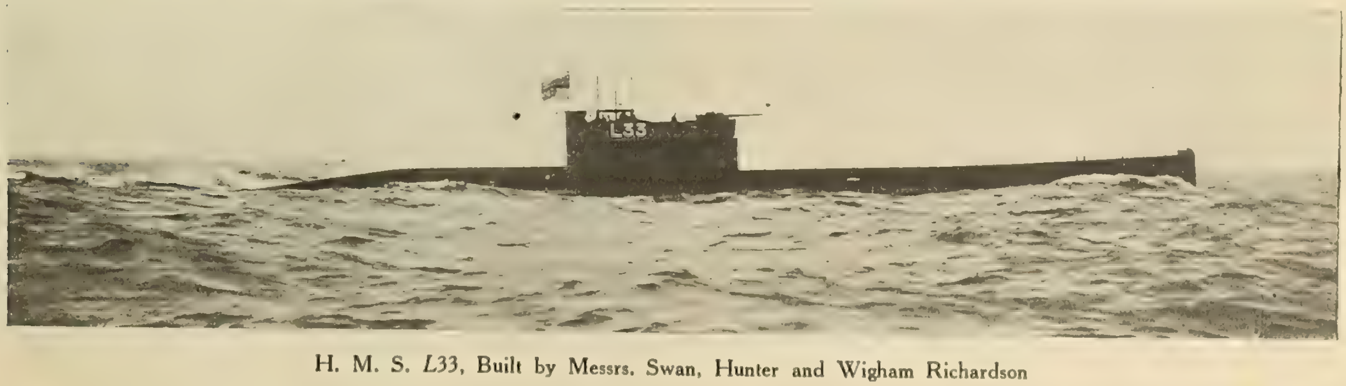
The class of submarine to which the *L*.33 belongs has been shown to be about the most useful and efficient for all-round ocean-going service. She shows marked improvements upon preceding ships, one of the most noticeable to an outside observer being the position of her gun, which is placed on a revolving platform on the conning tower instead of being fitted as in earlier ships on the forward deck, which is too low a position to work a gun easily except in comparatively fair weather.

In addition to her gun, *L*.33 has a battery of torpedoes which make her a most formidable craft. She is propelled on the surface by a twin set of internal combustion oil engines built at the Neptune Works of Swan, Hunter and Wigham Richardson. When submerged the ship is, of course, driven by electric motors, supplied with current from storage batteries.

In every part of the ship the latest machinery and apparatus known in submarine service have been installed. These are chiefly noticeable in the central control room, which is more spacious than is often found in submarines, and has been admirably planned to ensure the efficient and prompt working of the ship in action and at all times. A gyroscopic compass is installed, connected with several tell-tale cards placed in convenient positions. There are three periscopes of the latest pattern, fitted in the ship. A telescopic mast immediately abaft of the periscope carries the aerials for wireless telegraphy. The receiving and transmitting cabin is within the central control room, and in it are connections with the ship's hydrophones.

The ventilation of the ship has been very carefully studied, air trunks being led through every compartment. Electric fans in connection with these trunks ensure air being kept as fresh as possible in the dynamo and engine rooms as well as in the torpedo room and in other compartments of the ship, where there is accommodation for sleeping and messing. All cooking on board is done by electric ovens and hot plates.

The forward hatch of the ship gives access to the officers' quarters, which are handsomely panelled in



H. M. S. *L33*, Built by Messrs. Swan, Hunter and Wigham Richardson

polished mahogany. There is a most comfortable wardroom with sleeping quarters alongside. Between the wardroom and the central control room excellent living accommodation is provided for the petty officers and the crew.

Present Status of the Concrete Ship*

BY H. C. TURNER†

THE original concrete-ship program of the Emergency Fleet Corporation called for the construction of thirty-eight 7,500-ton vessels, three 3,500-ton vessels and one 3,000-ton vessel, making a total of 42 vessels. Immediately after the armistice, this program was reduced to eight 7,500-ton tankers, two 7,500-ton cargo vessels, three 3,500-ton cargo vessels and one 3,000-ton cargo vessel, or a total of 14 vessels. In October, 1919, the two 7,500-ton cargo vessels were canceled, leaving twelve vessels to be completed.

At this date, all of the four small cargo vessels are in service. They are the *Atlantus,* 3,000 tons deadweight, and the *Polias, Cape Fear* and *Sapona,* each of 3,500 tons deadweight. Of the 7,500-ton tankers, three have been launched, the *Palo Alto* at San Francisco and the *Selma* and *Latham* at Mobile. The remaining five tankers are in various stages of completion. It is expected that all will be in commission before June 1.

In addition to these vessels, twenty-one 500-ton canal barges were built by the Railroad Administration under the supervision of the Emergency Fleet Corporation. All of these barges are in service with the exception of one which was sunk in the Hudson river in the early part of December.

Construction Problems Successfully Met

In general, it may be said that in carrying out the concrete ship program, no construction problems have been encountered that have not been successfully met. The original design of the 7,500-ton tankers has been modified to some extent, owing to the discovery of undesirable high stresses in some of the members under test and service conditions. While the revisions contemplated involved concrete construction, seldom, if ever before, attempted, it is believed that the changes will remedy the undesirable conditions. The experience of the vessels in service thus far indicates that, so far as the cargo vessels are concerned, there is ample structural strength, and the barge is a much simpler problem.

The hope that reinforced concrete would provide a material from which hulls could be built with much greater speed than is possible in the case of steel has not been realized. The average time of constructing the concrete hull has been seven months. Outfitting and equipping the hull has taken on an average between three and four months. Undoubtedly, with the experience gained, this time could be materially bettered.

Service Records

The experience with the ships in service thus far indicates that they are great sea boats.‡ In every case of which there is record, these ships have behaved admirably in heavy weather, and have won considerable praise from officers and crews. There is generally very much less vibration in concrete ships than in corresponding steel ships. There is also a very considerable increase in the period of roll, which is quite desirable. The increase in the period of roll is undoubtedly due to the fact that these vessels have a relatively large moment of inertia around a longitudinal axis even when loaded with cargo. This is due to the mass of the concrete shell, which is considerably greater than the mass of the shell in a steel ship. In none of the vessels in service has any leakage whatever been reported. A few shear cracks are noticeable in the shell and bulkheads in all the ships in service, but these cracks are unimportant and have no apparent effect upon the structural strength of the ship.

One characteristic of the concrete vessels built by the Emergency Fleet Corporation should be noted in this connection. Experience seems to indicate that these vessels are unable successfully to withstand severe concentrated blows on the shell without the shattering of the concrete. Impact which, in the case of the steel ship, would probably only cause indentation to the plates, in the case of the concrete ship is apt to cause a shattering of the concrete over the area adjacent to the point of impact. A number of instances of injury of this kind have been observed, particularly in the case of the barges constructed by the Railroad Administration. In the case of nearly every barge the shell has been injured in one way or another, requiring repairs to the concrete. It has been found, however, that repairs are relatively simple and can be effected with little loss of time and at almost negligible cost. The barges in question have very little protection in the form of fenders. It is believed that where adequate fenders are provided, so that there is chance for the absorption of the work of a blow by means of some resilient material, such as an oak fender, this objectionable feature of the concrete barge may be obviated.

Deadweight Capacity Less Than Figured

The figures noted above for the deadweight capacity of the several ships constructed by the Emergency Fleet Corporation are the nominal deadweight capacities contemplated by the design. In no case has the nominal deadweight capacity of the ship been realized. The average deadweight capacity of the 7,500-ton tankers will be in the neighborhood of 6,800 tons. In the case of the *Atlantus,* nominally having a capacity of 3,000 tons, the actual deadweight capacity is 2,542 tons; the *Cape Fear* and *Sapona* nominally 3,500 tons, have deadweight capacities of 3,078 tons; the *Polias,* nominally 3,500 tons, built of heavy gravel concrete, has a deadweight capacity of 2,460 tons. It was expected that the ratio of deadweight capacity to displacement would run from 0.55 to 0.60. The actual ratio of deadweight to displacement will average but little more than 0.50.

In making a comparison between the relative carrying capacities of steel and concrete ships, one important consideration should be kept in mind. Taking into consideration a steel ship and concrete ship, each having the same deadweight capacities, the concrete ship—because of the greater weight of the ship itself—must have greater dimensions than the steel ship, and in consequence, must have greater hold spaces. For heavy weight cargoes, such as steel, coal or oil, in which the deadweight capacity is reached before the hold spaces are filled, it is apparent that steel has an advantage over concrete as a material of construction, assuming that the construction and operating costs are equal. For bulky cargoes, such as ordinary package goods, cotton, fruit or other materials for which the space required exceeds about 70 cubic feet to the ton, the

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* Abstract of report read before the American Concrete Institute, Chicago, February, 1920.

† Chairman of committee on reinforced concrete barges and ships.

‡ The *Polias* went ashore on the Maine coast near Penobscot Bay on February 6.

concrete ship will actually carry more deadweight than the steel ship for the reason that the hold spaces of the steel ship will be filled before the deadweight capacity is reached.

The cost of the small cargo vessels, leaving out of consideration the *Atlantus,* which was the first vessel built, varies from $210 to $300 per deadweight ton. The cost of the 7,500-ton tankers will vary between $200 and $250 per deadweight ton. These figures are based upon the nominal deadweight carrying capacity rather than the actual. These costs naturally include certain experimental work and other expenditures which could be reduced on future work, so that the above experience is not a sufficient basis on which to forecast the costs under peace conditions and skillful management.

Conclusions

No definite conclusions should be drawn as yet from the experiences of these vessels. It should be borne in mind that all the vessels were under construction at approximately the same time and that there was little chance to profit by experience. When it is remembered that these were the first vessels ever attempted of this size, the showing is not discouraging. The only general conclusion that may be drawn from the experience of the ships constructed under the direction of the Emergency Fleet Corporation seems to be that it is possible to construct ships of concrete in about the same time and for approximately the same cost as the corresponding steel ships. This indicates that, after there has been more experience in the art, it will be possible to reduce both the cost and the time for construction.

There remains only the question of length of life of concrete ships. Only time can safely answer this question, although it should be stated that the brief experience of the *Faith* and the Emergency Fleet vessels has disclosed no serious inherent weakness to shorten the life of the concrete ship.

Barges and canal boats, in order to have a commercial future, must apparently overcome two objections—first, a reduction in cost as compared with wood, and this may come through experience in design and construction; and, second, the development of a method to offset the damage sustained to the hull from slight collisions with tugs or other boats or in docking.

Another Diesel Electric Installation

CONSIDERABLE interest was aroused by the description appearing in the March issue of this magazine of the auxiliary schooner *Elfay,* which was the first Diesel electric drive installation on record. Since publishing the description of *Elfay's* remarkable power plant, Mr. Russel A. Alger, her owner, has made a trip of over 8,000 miles without having any trouble whatsoever with either the Diesel engine itself or with the electrical equipment.

As a direct result of the very satisfactory and efficient service rendered by the Winton Diesel electric drive equipment in the *Elfay,* Mr. Edgar Palmer has decided to equip his new boat with the same type of propulsion.

This new vessel will not only be the largest Diesel yacht ever built in this country, but also is the largest fore and aft auxiliary schooner yacht ever built in the world. This beautiful boat was designed by A. Loring Swasey, and the system of Diesel electric drive was worked out by him with suggestions from Commander Fisher, of the United States Navy.

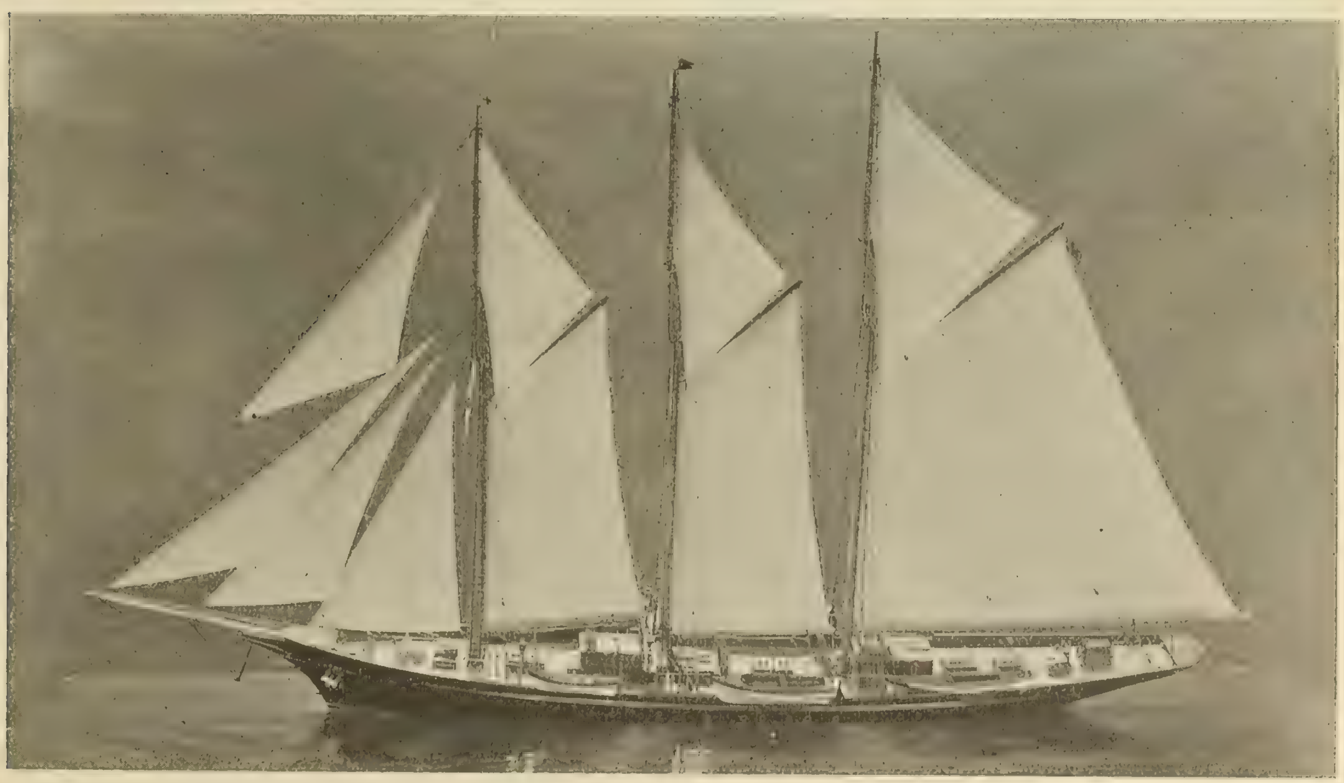

Fig. 1.—Model of Auxiliary Schooner Yacht *Guinivere*

Mr. Palmer's yacht carries a pair of Winton Diesel engines direct connected to generators which operate a driving motor, which in turn operates a large Bevis patent propeller. This gives the Diesel electric drive a better opportunity than was given it in the *Elfay,* as Mr. Palmer's boat can be run on one engine at slightly reduced speed and on both, if full speed is desired, giving a great factor of safety in case repairs have to be done to one of the units while underway.

To give an illustration of the great possibilities of this outfit as it will be installed in Mr. Palmer's new boat, which will be named *Guinivere,* after his other boat, it is of interest to compare the new boat with the old, as they are approximately of the same size.

Fig. 2.—Stern View of Model of the *Guinivere*

The old vessel had a Scotch boiler with quadruple expansion steam engine. With this outfit she carried 160 tons of coal and had a cruising radius of 4,000 miles. The new vessel carries 95 tons of oil and has a cruising radius of 11,000 miles. Moreover the engine room force will be reduced by six men, which today is quite an item of expense. The Diesel electric drive installation also allows of a much more roomy cabin arrangement below decks, giving more spacious living accommodations and a very much larger capacity for stores, etc.

With the new *Guinivere* there is no necessity for a smokestack, which is always a great bugbear on an auxiliary schooner; this type of installation also makes it possible to give one entire extra deck house. The exhaust is absolutely clean, running out of the after end of the boat under the surface of the water.

With the Winton Engine Works and the Westinghouse Electric and Manufacturing Company constructing the power plant, and with George Lawley & Son Corporation building the hull, this boat should be the finest possible example of what undoubtedly is a new era of ship propulsion, and is bound to revolutionize not only the powering of all large yachts, but will be a tremendous factor in working out true economy in the merchant fleets of this country.

Details of the New Yacht

The principal dimensions of the new *Guinivere* are as follows: Length overall, 195 feet; length on waterline, 150 feet; beam, molded, 32 feet 5 inches; draft, 15 feet; displacement, 642 tons; speed under power, 11½ knots; propeller, two-bladed, 8 feet 4 inches in diameter.

The vessel was designed by A. Loring Swasey, and is under construction at the yards of George Lawley & Son Corporation, Neponset, Mass. The power plant consists of a pair of 6-cylinder 350-horsepower model 24-A Winton Diesel oil engines, with a bore of 13 inches and a stroke of 18 inches, operating at 225 revolutions per minute. Each engine is direct connected to a 225-kilowatt, 125-volt Westinghouse shunt wound generator, each in turn operating by chain drive a 15-kilowatt, 125-volt direct current compound wound Westinghouse exciter turning at 1,150 revolutions per minute. This plant supplies electric power to the 555-horsepower, 250-volt Westinghouse motor operating at 220 revolutions per minute and located in the stern.

The auxiliary equipment consists of a 2-ton Clothel ice machine, a pair of 15-kilowatt generators for auxiliary work, each of which is operated by a 25-horsepower Quayle engine. All other auxiliary equipment throughout the boat, such as bilge pumps, fire pumps, service pumps, ventilating fans, hoists, both anchor and sail, wireless set, etc., are operated by electric power, no steam being used or required on the boat.

The installation of this power plant has been worked out under the active supervision of Mr. Alexander Winton, of the Winton Engine Works, and Mr. Wilfred Sykes, of the Westinghouse Electric and Manufacturing Company.

Operation of the Machinery

One of the interesting features of the installation is that the generators will be not only ringed oiled, as is the usual practice, but provision is also made for flooding them with oil from the oil system of the Winton Diesel engines. This provision is made so that they will operate satisfactorily no matter what the list of the ship may be.

The driving motor will be enclosed at its forward end and will have an inlet at the top of this end for the entrance of the cooling air. Centrifugal fans direct connected to a 1¾-horsepower motor will furnish approximately 3,500 cubic feet per minute of air for the ventilation of this motor.

The method of operation for this drive is practically the same as used in the auxiliary schooner yacht *Elfay.* For normal operation at full power the two main generators are connected in series furnishing power to the motor. The generators and motor are arranged for separate excitation at 125 volts on the exciter circuit. The speed of the motor from zero to maximum in either direction is controlled by means of the reversing rheostat which controls the excitation of both generators, thus controlling the generator voltage and therefore the speed of the motor. This arrangement makes it possible to operate the ship at almost any speed desired up to the maximum ahead or astern. It also allows for reversing without interrupting the main circuit.

Unlike the *Elfay,* the *Guinivere's* power plant will be

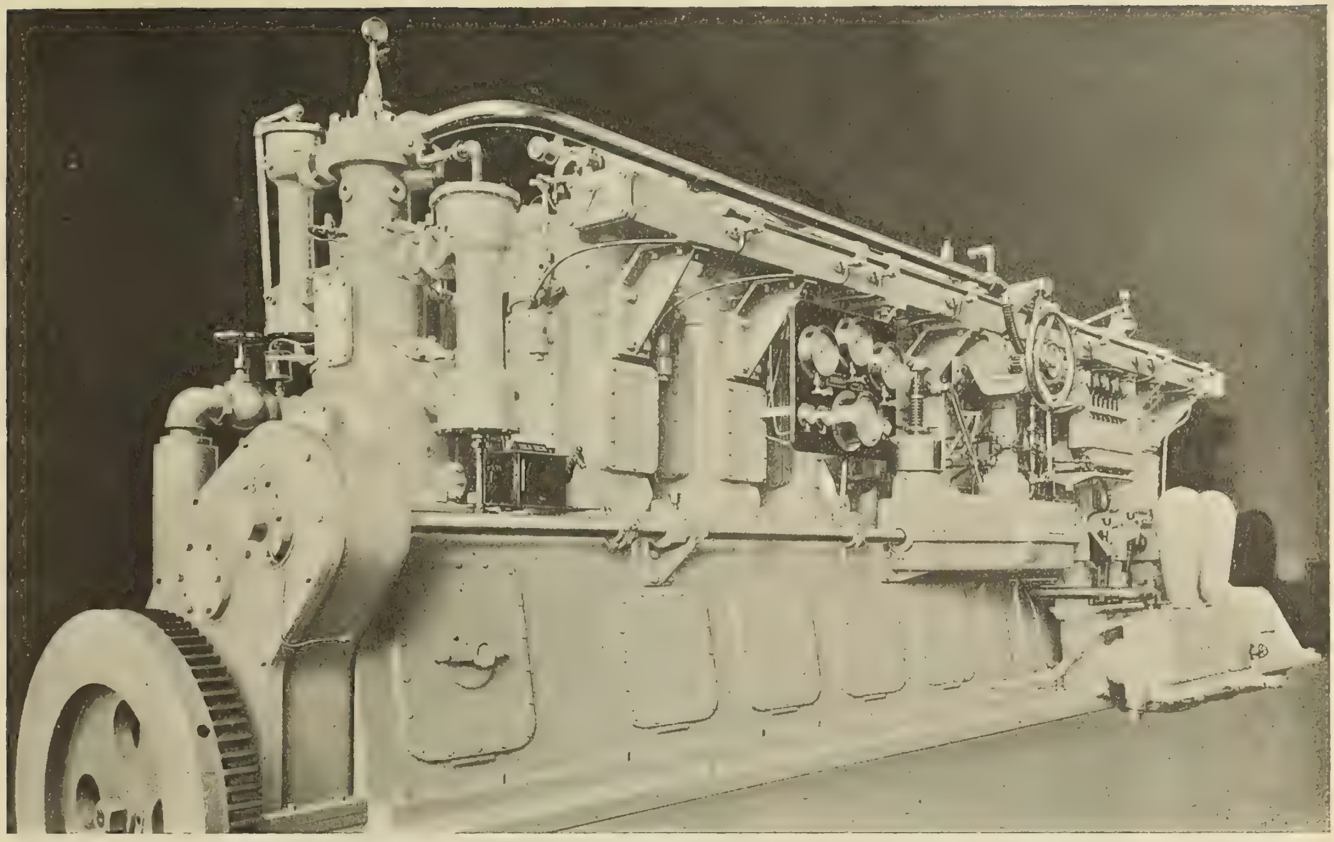

Fig. 3.—View of Six-Cylinder Winton Diesel Oil Engine Installed in the *Guinivere*. Bore, 13 Inches; Stroke, 18 Inches

controlled from the engine room by signals from the pilot house. The reversing rheostat will be mounted at the rear of the main switchboard panel, and will be operated by a hand wheel suitably marked on the front of the panel board. In addition to the reversing rheostat this panel will carry an automatic circuit breaker for overload production, meters, knife switches for generator and motor field circuit, a two-pole double throw knife switch for each main generator armature circuit. By means of the latter switches, each generator may be connected in series with the other generator or disconnected, leaving the other generator connected to the motor. This arrangement makes it possible to operate at reduced speed when one generator is shut down or when it is desired to operate the ship at low speed for a considerable time. Each of these switches will have extra terminals to allow for connection to the anchor windlass motor switch on the auxiliary control panel in case of the necessity of using power over and above that supplied by the auxiliary generating units.

The Westinghouse Geared Turbine

Declaring that the geared turbine is beyond the experimental stage, Norris R. Sibley, in a talk before the recent meeting of the Ocean Association of Marine Engineers, held in New York City, brought out various salient considerations explaining the reasons why the marine geared turbine has proved its superiority over the reciprocating engine.

Mr. Sibley, who is connected with the marine department of the Westinghouse Electric & Manufacturing Company, stated that there are over 100 ships in active service equipped with the geared turbines made by his company. A number of these ships have been in commission for over two years, and several have records of over 100,000 miles.

He attributed the increasing use of the marine geared turbine to three main reasons, as follows:

1. It is economical in fuel consumption because it is able to operate with a very high vacuum. This makes it more efficient than the reciprocating engine and enables it to take a vessel over a given voyage with from 10 to 25 percent less fuel.
2. Greater cargo space is secured, as the geared turbine is smaller and lighter than the reciprocating engine of the same horsepower.
3. The turbine, being simpler in construction, is easier to operate and keep in condition.

The speaker then explained, with the aid of stereopticon views, steps in the manufacture of turbines, reduction gears, condensers, pumps, propeller shafts and other apparatus manufactured at the new Westinghouse plant in South Philadelphia along the Delaware river.

New Plant Required

He stated that prior to 1918 the marine turbines had been made at the East Pittsburgh plant, but that, because of the increased volume of this class of business, it was decided to erect a plant exclusively for the manufacture of this apparatus. The new plant, which is of thoroughly modern construction, has a floor area of 7 acres and gives employment to 5,000 workers.

One of the reasons advanced by the speaker why the turbine has gained so much popularity is the establishment of schools by the recruiting service of the Shipping Board, which give instruction in turbine practice. These schools are located at the plants of the turbine manufacturers. Chief engineers and first assistants, who are handling or expect assignments to turbine-equipped ships, are sent to these schools, with shore pay, traveling and sustenance allowances. Here they obtain practical instruction in the operation, erection, care and repair of turbines, gears, condensers, electrical machinery and auxiliaries.

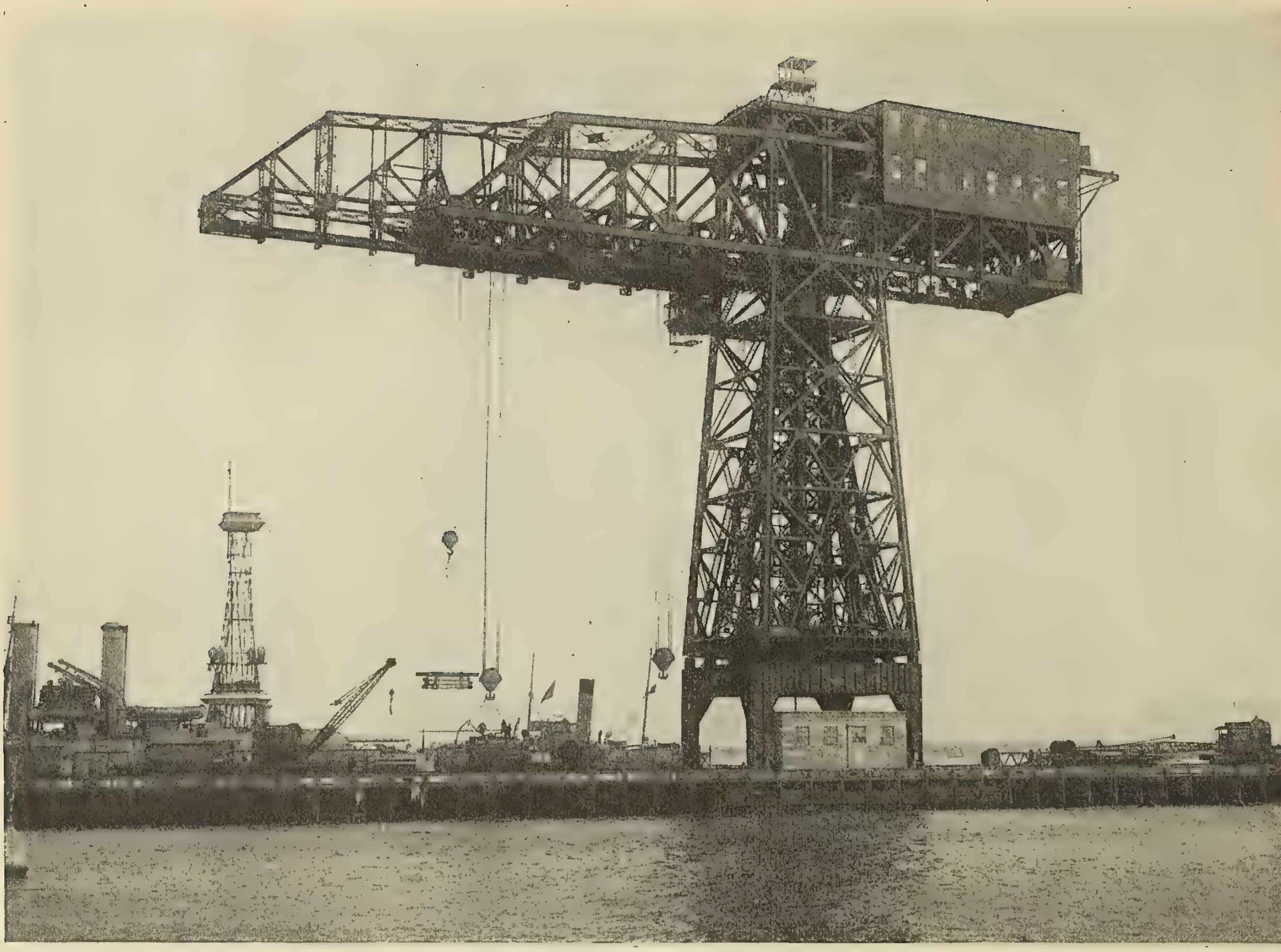

Fig. 1.—New Fitting-Out Crane at Philadelphia Navy Yard

The Largest Fitting-Out Crane in America

350-Ton, Hammer-Head Crane Erected on Fitting-Out Pier of League Island Navy Yard—Built by McMyler-Interstate Company

(*Photographs by Edwin Levick, New York*)

THE largest crane of its type in America, with a lifting capacity of more than a million pounds, has been completed and put in operation at the League Island Navy Yard, Philadelphia. The crane is located on the recently constructed 1,000-foot fitting-out pier at the yard, and its completion represents a definite step in engineering progress.

An idea of the size may be had from the fact that a ten-story building could be placed under the jib of the crane and that its overall height is over 245 feet, or about that of a 17- or 18-story building. The cost of the entire crane structure above the foundations was approximately \$875,000 (£180,000), and of the foundations \$120,000 (£24,600).

Tests of the new crane, in the course of which it was loaded to 125 percent of rated capacity and operated in all cycles of duty, have recently been concluded. The largest single load in these tests was 980,000 pounds. The most spectacular of these tests was the lifting of a total load of 1,010,000 pounds—a locomotive weighing 100,000 pounds on the auxiliary (50-ton) hoist, a load of steel billets weighing 416,000 pounds on each of the main (175-ton) hoists, and a locomotive weighing 78,000 pounds on the machinery house crane.

The maximum capacities, 50 gross tons for the auxiliary hoist and 350 gross tons for the main hoist, were determined in conjunction with the Bureaus of Construction and Repair and Steam Engineering as ones that would permit turrets, guns, etc., to be completely assembled (except for armor plating) in the shops at the Navy Yard and transferred to the ships on barges or cars and placed on board the vessels intact, eliminating the operations of dismantling and subsequently reassembling on board ship usually necessary, with a consequent marked increase in economy of time and money in the construction of capital ships. The large weight-handling capacity will also make the crane of inestimable value in the performance of major repairs to vessels.

The location of the crane at the waists of the ships berthed on either side of the pier will permit the placing of most of the heavy weights without moving or turning the ships. The placing of minor parts, which forms the greater proportion of the work of fitting out a ship, will be rapidly and economically done by two auxiliary, small capacity (5 to 10 tons), quick-acting cranes of the same general type, but with a traveling instead of a fixed tower, and smaller height and reach, which will be installed to operate along the pier on each side of the main crane.

Fig. 2.—Cantilever Jib

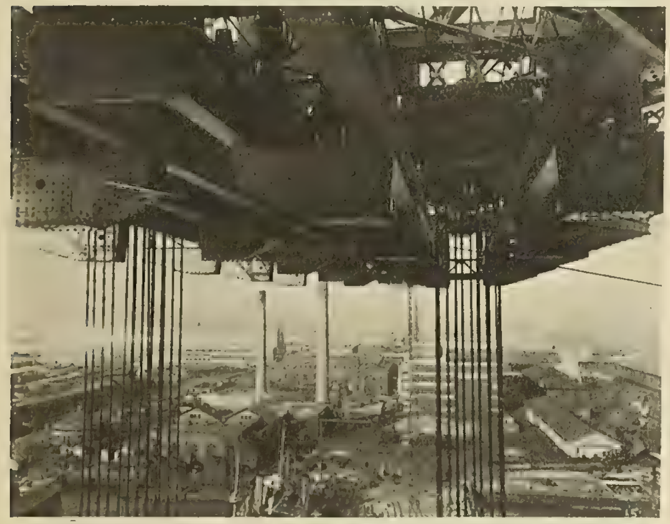

Fig. 3.—Underside of Cantilever Jib

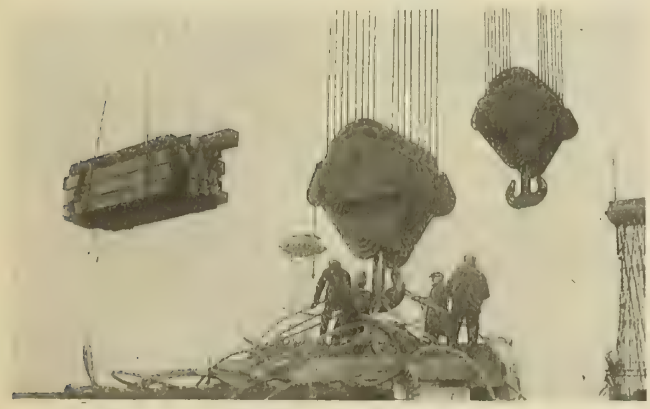

Fig. 4.—Main and Auxiliary Hoists

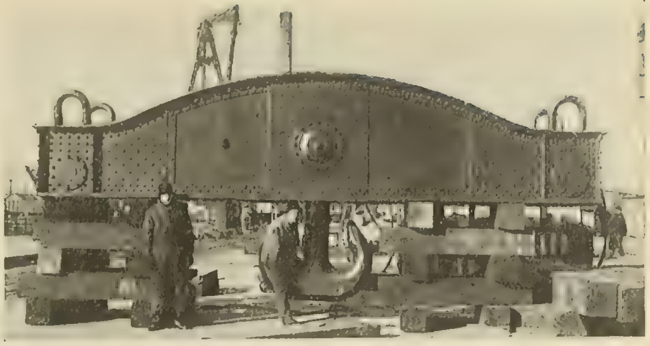

Fig. 5.—Main Hook

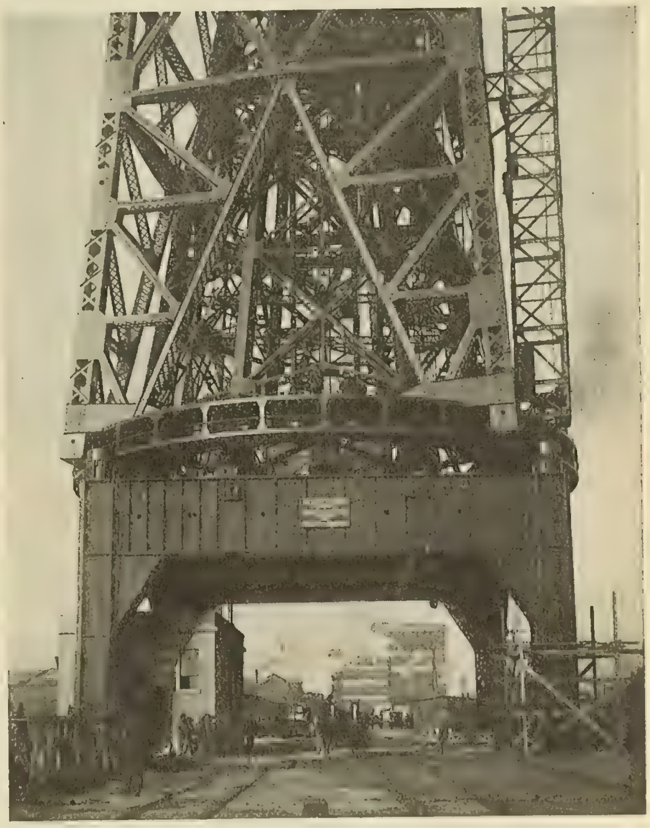

Fig. 6.—Fixed Portal and Base of Tower

In some cases it is contemplated that these cranes may also be supplemented by floating derricks where it is desirable to expedite the construction by placing medium weights beyond the reach of the pier cranes without moving the ship.

GENERAL DESCRIPTION OF CRANE

The crane, as designed and constructed, consists of a fixed portal 56 feet square, supporting on deep girders an octagonal tower about 56 feet wide at the bottom and tapering to a bearing pintle 5 feet in diameter at a height of approximately 201 feet above the deck of the pier. Supported vertically on this bearing pintle and revolving thereon is a horizontal cantilever jib or boom 300 feet long over all, to which is readily attached a "petticoat" which envelops the fixed tower from the bottom of the jib down to a height just above the portal. The entire vertical load from the hoists is transmitted to the tower at the pintle, mentiond above, but lateral thrusts are taken into the fixed tower at the pintle and into the circular girder at the base of the octagonal tower by the circular girder which forms the rim of the "petticoat."

The forward cantilever of the jib contains the three runways for the trolleys that carry the loads. The rear cantilever of the jib carries the counterweight and the house containing the machinery and drums for hoisting and lowering loads and racking the trolleys in and out on the forward cantilever. The machinery for revolving the jib is located at the level of the top portal girder and the rotating impulse is transmitted through the rim of the "petticoat."

This enveloping "petticoat" provides a greater than usual factor of safety against failure by overturning of

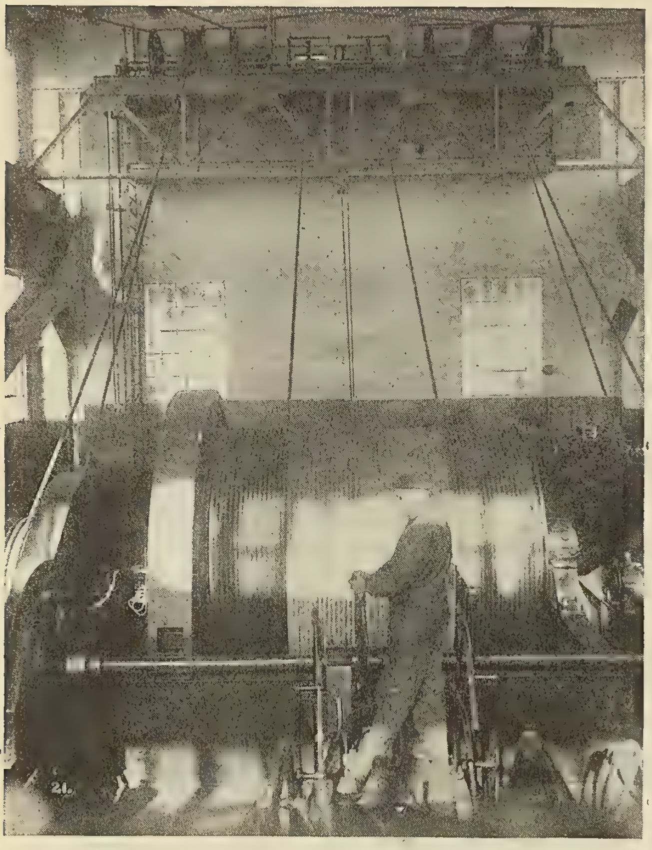

Fig. 7.—Main Hoisting Drum

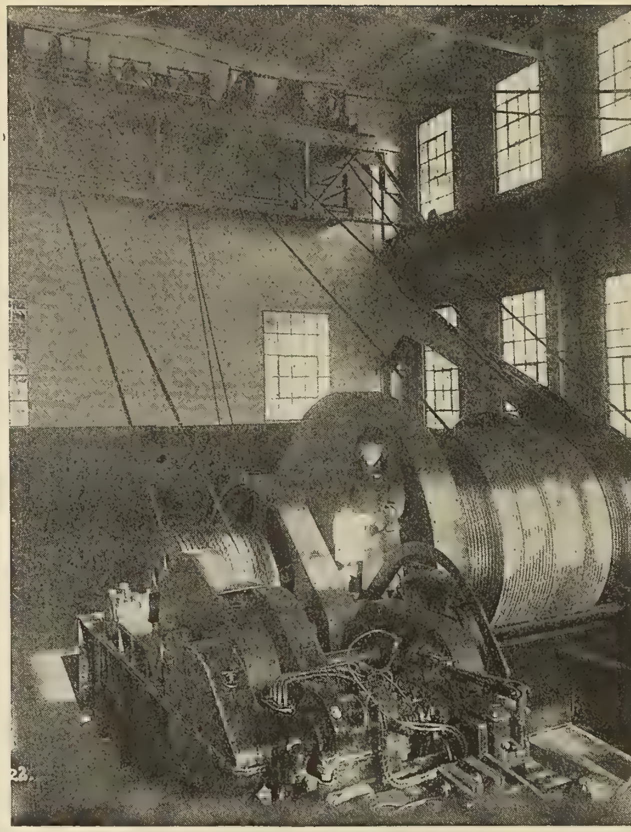

Fig. 8.—Main Hoisting Motors

the jib, in the event of excessive accidental overload of crane, than would be given by the other and more usual design under consideration by the Bureau, in which the jib is simply supported by the tower on a circular bearing similar to that of a swing bridge or a turntable. The entire framework of the crane is of structural steel of bridge grade and the entire operation is by means of electricity.

Access to the jib machinery house, etc., is provided by

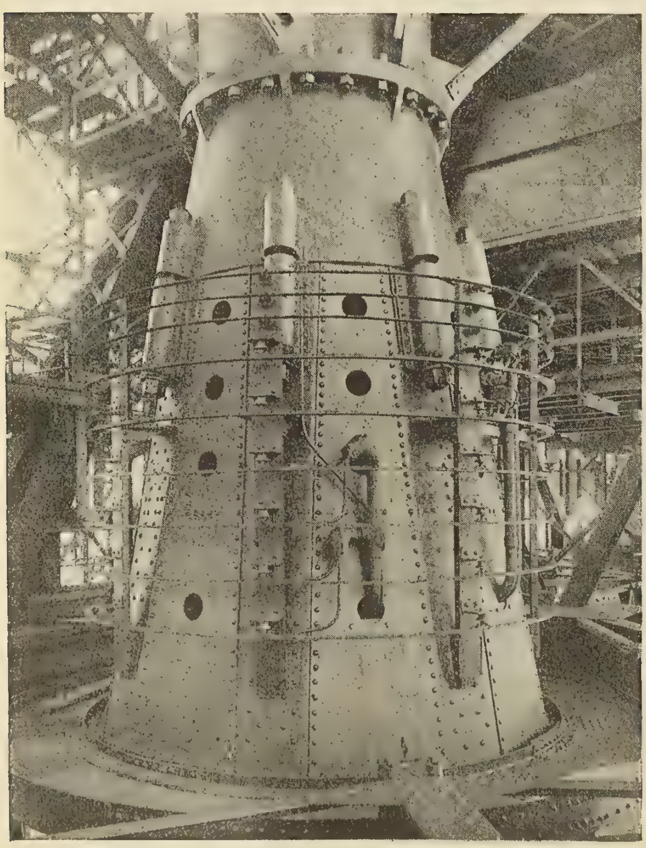

Fig. 9.—Revolving Head of Tower

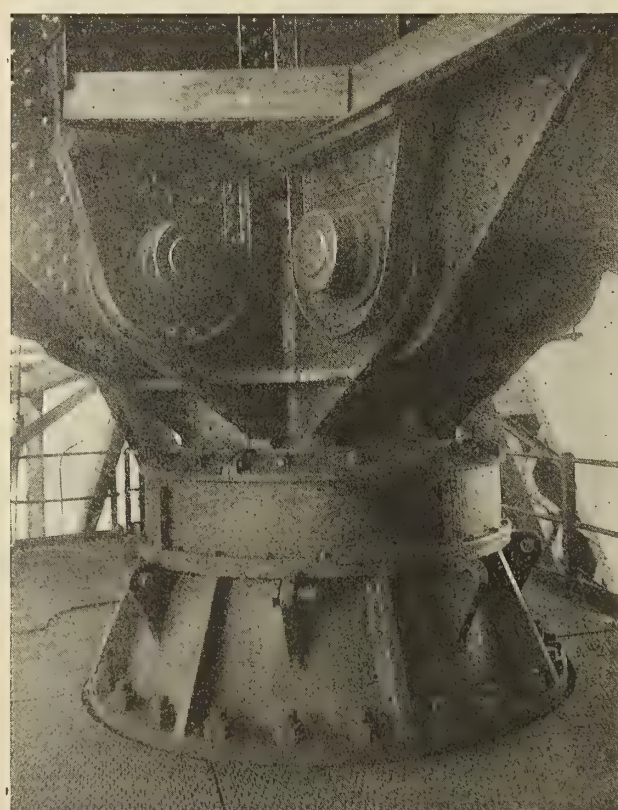

Fig. 10.—Main Pintle

means of a steel stairway in the tower and an electrical elevator mounted on the outside of the "petticoat" and the jib.

Details

The forged steel hooks by which the loads are raised have, in the case of the 175-ton hook, a shank 9 inches in diameter and, in the case of the 350-ton hook, a shank 13 inches in diameter. The 50-ton block and load are carried by eight 1⅜-inch wire ropes; the 175-ton block and load by sixteen 1⅝-inch wire ropes running on 50-inch pulleys, and the 350-ton block and load by thirty-two 1⅝-inch wire ropes. The 350-ton block is carried from the two 175-ton blocks by a steel equalizing beam 4 feet 10½ inches deep.

The clear lift of the main hook is 141 feet above and 29 feet below the deck of the pier, and of the auxiliary hoist 151 feet above and 29 feet below. The three trolleys carrying loads in and out on the forward cantilever of the jib operate on separate runways, the one 50-ton trolley to a distance of 190 feet from the center of the tower and the two 175-ton trolleys to a distance of 115 feet from the center of the tower. The two 175-ton trolleys are arranged so that they can be coupled together in order to lift, by means of the additional hook and equalizing beam above mentioned, the capacity load of the hoist, 350 gross tons or 392 short tons.

The forward cantilever is 200 feet long, 40 feet wide from the tower to the limit of travel of the main hoists,

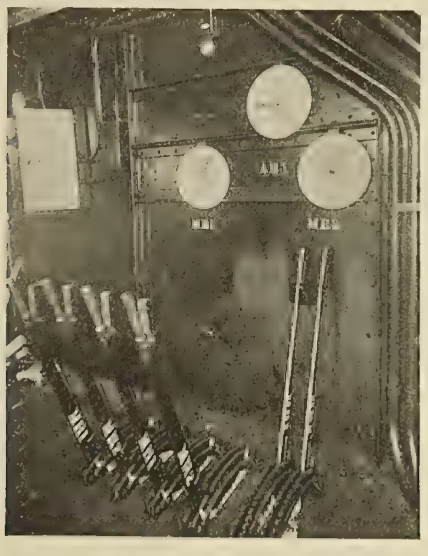

Fig. 11.—Levers for Operating Clutches

and 13 feet 4 inches beyond that. Its trusses have a depth of 40 feet at the tower.

The rear trusses, carrying the machinery house and the counterweight, are 100 feet long and 20 feet deep and form a cantilever 40 feet wide.

The machinery house itself is a large building—80 feet long, 43 feet wide and 32 feet high—and contains the machinery for hoisting and lowering the hooks and for racking the trolleys. The two main hoisting motors and the one auxiliary hoisting engine are of 87 horsepower each; the two main racking motors and the one auxiliary racking motor are 27½ horsepower each. The drums on which the ropes for the main hoist are wound are 10 feet in diameter and 14 feet long and revolve on a drum shaft 10½ inches in diameter.

The machinery house also carries an overhead traveling crane of the bridge type of 35 tons capacity (determined by the weight of the main drum and drum shaft) for the handling of machinery. The runway on which this crane operates extends through the rear wall of the machinery house a distance of 17 feet. By lowering the rear wall of the house, which is especially designed for the purpose, the crane is permitted to travel out beyond the end of the building in order to transfer parts to and from the pier, about 215 feet below.

The counterweight is of concrete and weighs 628,000 pounds.

The pintle supporting the rotating part of the structure (the jib and "petticoat") is of cast steel, 60½ inches in

Fig. 12.—Controllers

diameter, and when the crane is loaded to rated capacity carries a vertical load of 5,834,000 pounds and takes a lateral thrust due to maximum conditions of wind, loading and eccentricity of 607,000 pounds. The vertical load is taken by means of 220 roller bearings 3 inches in diameter and the horizontal thrust by 62 rollers 2 inches in diameter. The metal of the bearing rollers is a high carbon, high chromium tool steel with the exceptional ultimate bearing strength of 290,000 pounds per square inch after hardening treatment (raised from 96,000 pounds per square inch before treatment).

The eccentricity mentioned is due to the fact that the jib is designed so that the overturning moment, or tendency of the jib to overturn, is equal and opposite in direction under each of the two conditions of no loading and maximum rated load; in case of no load on the crane, the center of gravity of the rotating mass is 12.45 feet behind that of the tower, and in the case of maximum load 10.65 feet in front of that of the tower. This tendency toward overturning is resisted by the horizontal bearing of the bottom rim of the "petticoat" on the circular girder encircling the tower legs, as well as by the horizontal bearing at the pintle, and in the case of that due to vertical loads, is neutralized at the top of the portal girder. The horizontal thrust at the bottom rim of the "petticoat" is taken up by means of sixty-four 26-inch wheels mounted on two chains and bearing on a circular girder 55 inches deep and 64 feet in diameter.

The slewing or revolving mechanism located at the top of the portal consists of an 87-horsepower motor with gearing, driving four pinions working in a rack 64 feet in diameter, having 768 teeth of 3.1416-inch pitch and 12-inch face.

The operating speeds of the crane are as follows:

Hoisting—
Main hoist, 2½ feet per minute.
Auxiliary hoist, 15 feet per minute.

Racking—
Main trolley, 15 feet per minute.
Auxiliary trolley, 80 feet per minute.

Revolving—One complete revolution in 12 minutes.

All of the operations of the crane are controlled from an operator's cab located under the jib adjacent to the tower and in full view of all of the handling operations of the crane. The machinery is controlled from the cab by means of master controllers operating solenoid switches located in the machinery house. Clutches for throwing the hoists into high or low gear and for coupling together the main hoists when using the equalizer beam are located in the machinery house and are mechanically operated by levers in the operator's cab.

The structure is designed so that when it becomes necessary to renew pintle bearings or make repairs the entire rotating structure (the jib and "petticoat") can be jacked up from the portal by means of four 30-inch jacks of 560 tons capacity each.

The portal has four legs, spaced 56 feet center to center, each of a sectional area of 385 square inches of structural steel, supporting the massive girders 9 feet deep, which carry the octagonal tower. The maximum load on one of these legs was computed at 3,000,000 pounds under maximum conditions of wind pressure, and for this load the legs and the foundations were designed. The portal has a clear height of 25 feet 7 inches, which provides ample clearance for locomotive cranes or other equipment on the two tracks passing through it. A power substation which furnishes the electrical current for the operation of the crane is also located beneath the portal.

The entire deadweight of the crane structure is calculated at 4,000 tons. An uplift of 59,000 pounds being possible in any one leg due to maximum wind loads on the structure, four bolts 3 inches in diameter are used to anchor each leg to the foundations.

Each of the four tower legs is supported on grillages 10 feet 4 inches square, made up of two layers of rolled steel girders embedded in massive reinforced concrete caps 35 feet 4 inches square and 9 feet 6 inches deep, tied securely together longitudinally and transversely by the deep reinforced concrete girders of the pier deck. Each of these caps rests on 156 timber piles driven to the hard cemented gravel river bottom and cut off at water level. These piles are supported laterally by an earth fill inclosed and retained by reinforced concrete sheet piles jetted and driven into the hard river bottom. Most of these sheet piles are 18 inches by 24 inches in section and 52 feet long. They weigh about 12 tons, are tongued and grooved to interlock one with another to form a reinforced concrete wall around the entire foundation 24 inches thick, and spanning from caps and lateral connecting girders to the river bottom.

The crane structure was designed by the McMyler-Interstate Company of Bedford, Ohio, under the general supervision and in accordance with the specifications of the Bureau of Yards and Docks, Navy Department, and was erected by that company under the supervision of the Public Works officer at the Navy Yard. The contract for the crane was awarded to the McMyler-Interstate Company in January, 1918, and the erection was begun in April, 1919, and completed in December, 1919.

The foundations were designed by the Bureau of Yards and Docks and constructed by the Snare and Triest Company of New York City as a part of the 1,000-foot by 100-foot fitting-out pier. This construction was also under the general supervision of the Public Works officer of the Navy Yard.

Merits of Corrugated Bulkheads

A PAPER read before the Northeast Coast Institution of Engineers and Shipbuilders by Archibald Hogg on "A Test of Watertight Bulkheads for Ship Subdivision" gave rise to an interesting discussion, in the course of which the corrugated bulkhead advocated by the author was the subject of considerable criticism. The two most important disadvantages of the corrugated bulkhead were stated to be the extra cost and the reduction of stowage capacity which its adoption would entail. "To both of these points Mr. Hogg was able to give a satisfactory reply," says a report of the discussion. "With regard to cost, it was pointed out that the steel saved per bulkhead, say ten tons, was all in the form of stiffeners and brackets on which the labor saved, which included riveting, amounted to about £35. Against this had to be charged the cost of rolling 18 plates and of setting four bars for the curved plate bulkhead, totalling about £10 to £15. With steel at present prices the total saved ought to be well over £100 per bulkhead. On the question of stowage in way of curve-plated bulkheads, the author suggested that inspection of an actual bulkhead with its wide shallow curves would satisfy those who raised the point that the stowage was at least as good as that obtainable with the many stiffeners and brackets of the flat bulkhead. The curve-plated bulkhead did not add to the bale-carrying capacity, he said, though it added about 100 cubic feet to the grain capacity by the volume of steel saved."

Lighting Sets of the S. S. St. Paul

THE S. S. *St. Paul*, of the American Line, which turned over in her slip two years ago, has been reconditioned and has resumed her passenger service between New York and Southampton. Her rehabilitation is a splendid example of American achievement, and henceforth her passengers will enjoy even greater comfort and service than they were accustomed to in the old days.

Apart from the fact that the accident had rendered the old lighting set on the vessel practically worthless, it was necessary to install units that would satisfactorily meet the increased power demand caused by the addition of several new electrical conveniences. In order to do this, five Westinghouse engine generator units of 35 kilowatts each were requisitioned. These are located just forward of the engine room, and each consists of a vertical 9-inch by 8-inch single-cylinder Sturtevant engine, operating at 400 revolutions per minute, with steam at 125 pounds pressure, condensing into a 26-inch vacuum. This engine is coupled to and mounted on a common base with a Westinghouse direct-current, 125-volt, 400 revolutions per minute generator, with non-corrosive parts and impregnated coils to afford protection against moisture. The five units may be operated individually or in parallel, according to the load demand.

In addition to lighting the ship these sets supply power for the elevator, stateroom heaters and radio set, and also an electric dishwasher, a dough mixer, potato peeler, toasters, plates and smoke-room boiler.

As will be observed, electricity plays a large part in the comfort and efficiency of this ship; and although the *St. Paul* has plied the Atlantic for many years, she is still in condition to hold her own as a first-class passenger ship.

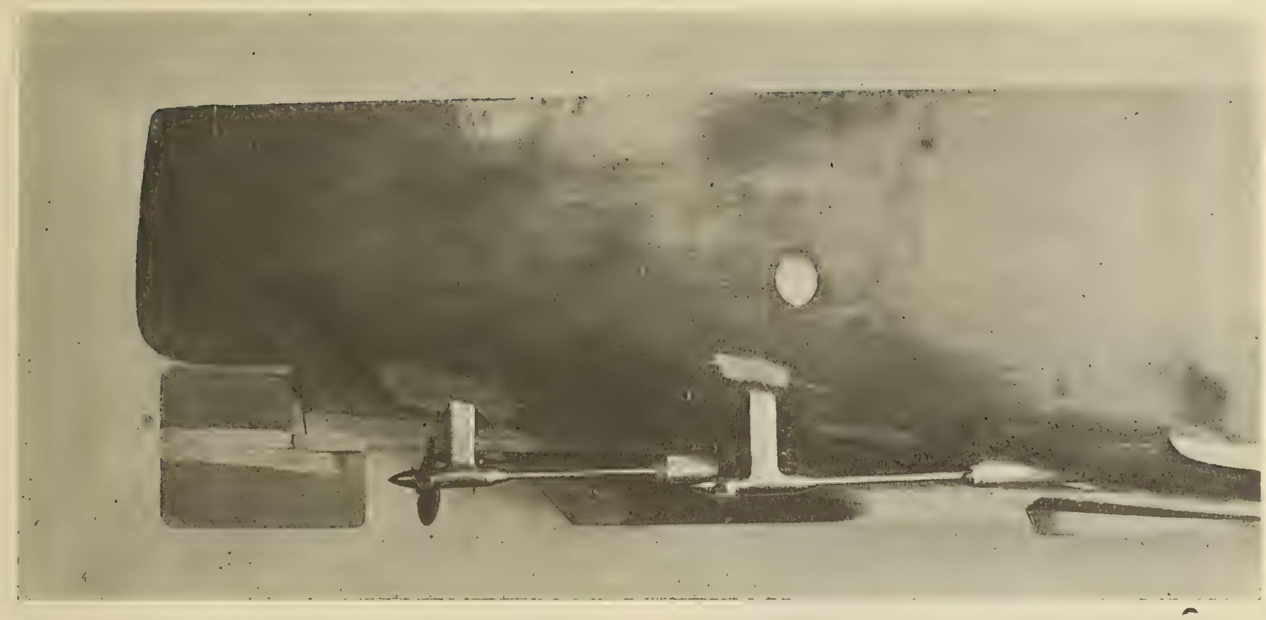

Fig. 1.—Side View of Stern, Showing Arrangement of Shafts, Struts and Propellers as Tested in the Model Basin

Estimates of Propeller Performance from Self-Propelled Model Tests

BY COMMANDER WILLIAM MC ENTEE, CONSTRUCTION CORPS, U. S. N.

DURING the last four years there has been developed at the Experimental Model Basin at the Washington Navy Yard an interesting and valuable method of testing the models of ships with the propellers in place and actually propelling the model. Sufficient experience has been had to indicate that the method is capable of giving very accurate results. It also has been of much value to the Bureau of Steam Engineering in supplying an independent check on propellers designed by Dyson's well-known method. The subject should, therefore, be of interest to naval architects and marine engineers who in the estimate of power requirements for new ships must take two important steps in the design of a ship and its propelling machinery:

(1) The selection of suitable lines for minimum resistance and the estimate of the effective horsepower required at different speeds.

(2) The selection of a suitable propeller so that the power of the machinery may be applied to the propulsion of the ship most effectively.

When there is a happy solution of both requirements (Nos. 1 and 2), the resulting design is one which is economical in both fuel used and in weight of the machinery installation.

As regards the determination of the form of the hull, experience in the use of Froude's law of comparison in testing models in model tanks in different countries has amply demonstrated its accuracy. It is in fact the only satisfactory method of estimating the effective horsepower required for a ship when its lines differ in a material degree from those of previous models and ships tested. Moreover, there has been a large amount of experimental data made public with regard to the factors affecting a ship's resistance, so that with intelligent application of the same a fairly close estimate may be made for ships of normal type.

When it comes to the design of a propeller to use on a particular ship, there is inherently a more difficult problem to solve. The performance of a propeller alone, even when running in free undisturbed water, is dependent on so many variables that it is a very complex subject. When to these complexities of the propeller alone are added those due to the form of the ship's hull itself, it is readily seen that there is greater need for an accurate model-testing method for estimating power requirements for a given combination of hull and propeller than there is for estimating the performance of either by itself.

For the propeller alone, the experimental field has been well covered in the researches of Froude in England and Taylor and Durand in this country, as well as by those of other investigators in Germany and elsewhere. These experiments have served to clear up to a large extent the haze which until comparatively recently seemed to surround the conceptions of propeller action. In fact, the experimental data derived by these investigations have served to discredit many mathematical theories of the propeller, so that at the present day, so far as the writer is aware, there is not a single rigidly rational propeller theory which fully explains the observed phenomena or which may be used with certainty to predict the performance of a new type of propeller.

It may be considered, then, that the information available as to the lines of ships' hulls and the performance of propellers of conventional form in free water are sufficient for all ordinary purposes. It is when seeking to estimate the effect of combining a certain propeller with a certain hull that there are introduced elements of doubt which may lead to important errors in estimates of shaft horsepower or revolutions of the propeller.

Recognizing this difficulty, Rear Admiral Dyson has developed a method of design which is based on the trial results of actual ships. The estimates obtained by his

method are entirely satisfactory when the ship and propeller fall in the range of variables covered by existing trial data. It is apparent that, with the almost unlimited number of possible variables in form of hulls and propellers, it will require many years and the trials of many ships before it becomes of universal applicability.

There is, therefore, a real necessity for a method of testing models of the hull and propeller running together. Experimental work of this kind has been done by Froude and Luke in England, but their published results are limited to statements of certain factors, such as wake and thrust deduction coefficients resulting from certain combinations of hull and propeller. There are no data available to show how close the agreement between the performance of the full-size ship and those estimated from the model tests is. The arrangement of the test apparatus used by them is open to the criticism that it does not completely fulfill the requirement of similarity between ship and model, as the propeller is not carried by a shaft extending from inside the model, but by a separate shaft wholly outside of it and supported by separate attachment to the towing carriage.

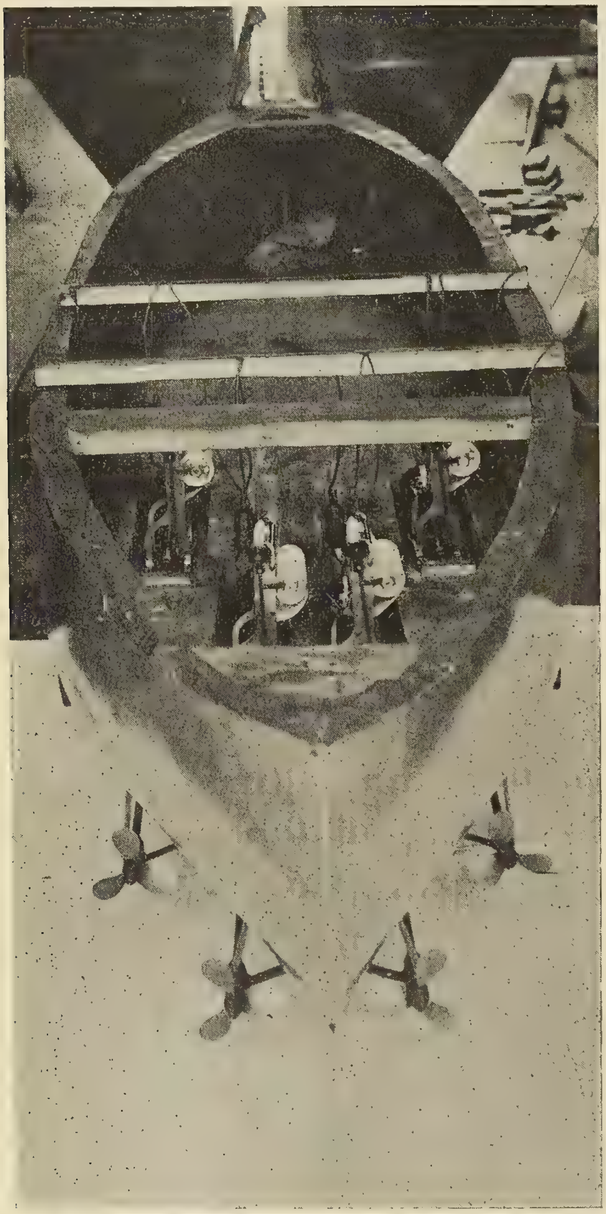

Fig. 2.—Stern View, Showing Shafts, Struts, Propellers and Dynamometers in Model as Tested in the Model Basin

The following is a description of the method as developed and used at the Washington Model Basin with comparative results of model tests and ship trials for the U. S. S. *New Mexico*.

The model to one-thirtieth scale was fitted with all appendages and with shafts, struts and propellers to scale in accordance with plans of the ship and machinery as built. The appearance of the model fitted with propellers is shown in Figs. 1 and 2.

In making the tests each shaft was driven by a small direct-current motor coupled directly to the shaft. Each motor was arranged as a dynamometer with calibrated springs which permitted simultaneous measurement of torque, revolutions per minute and thrust on each shaft, while the model was self-propelled under the Model Basin towing carriage. The model was arranged so that the towing carriage would steer it in a straight course while running at a uniform predetermined speed. The model was free to gain or lose a distance of about six inches as compared with the towing carriage before it would strike stops. During the course of each run the speed of the propellers was adjusted so that the model was running under its own power at a speed just equal to that of the towing carriage. When the model was running uniformly, so as not to strike either stop, cards recording the revolutions per minute, thrust and torque on each shaft were taken simultaneously. The speed of the model was taken by a card on the towing carriage in the same manner as when making model resistance experiments. A sample dynamometer card is shown in Fig. 4.

The results of the experiment are shown in Fig. 3 and in the following table.

TABLE I.—COMPARISON OF SHIP TRIAL DATA (U. S. S. *NEW MEXICO*) WITH MODEL TEST RESULTS

Speed of Ship on Trial, Knots	Revolutions per Minute		Shaft Horsepower		
	From Model Test	On Ship Trial	From Model Test	Ship Trial, Torsion Meter	Ship Trial, Electric
9.92	77.95	77.93	2,915	3,144	2,948
14.91	114.50	114.89	8,818	9,021	9,073
16.84	131.10	131.38	13,285	13,481	13,919
18.95	148.00	148.94	19,600	20,662	21,403
20.68	163.60	163.45	27,130	27,292	29,082
21.31	170.00	170.27	31,230	31,357	33,722

An examination of the table and Fig. 3 will show that the revolutions per minute, as estimated from the model tests, agree remarkably well with the revolutions per minute as determined on the ship's trials, the difference being less than ½ of 1 percent, except at the speed of 18.95 knots, at which there is a difference of nearly one revolution. The shaft horsepower as estimated from the model also agrees very well with that obtained on the trial of the ship, excepting that at the same speed, where the difference is about 1,000 shaft horsepower, or 5 percent. In Fig. 3 it will be noted that the slope of the power curve at the higher speeds as determined from electrical measurement agrees very well with the slope of the power curve estimated from the model experiments. The electric power given is from the observed electric input to the motors on the standardization trials of the ship corrected for the estimated motor losses, so as to give the estimated net shaft horsepower delivered by the propelling motors at the motor couplings. This power is about 8 percent higher than that given by the torsion meters and as estimated from the Model Basin tests. This appears to be a larger difference than would be expected to be accounted for by the thrust and other bearing losses which are not included in the model test results or in the torsion meters on the ship trials.

From this comparison, and considering also the results obtained on the trials of a sister ship, the U. S. S. *Idaho*, it is believed that the trial data on the ship's trials at the

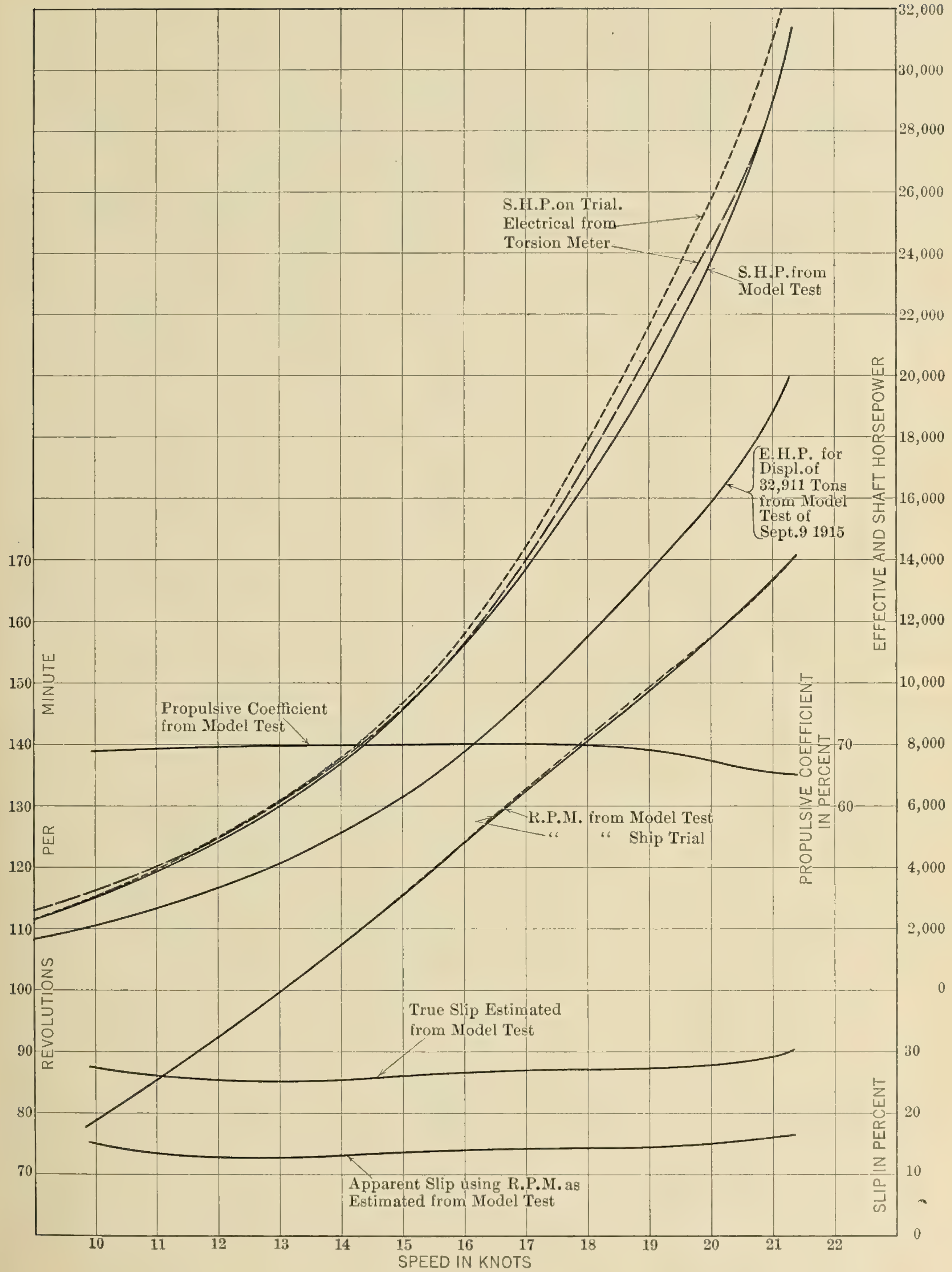

Fig. 3.—U. S. S. *New Mexico.* Comparison of Power and Speed Data on Standardization Trials with Results of Self-Propelled Model Tests (Model No. 1642). Standardization Trials of December 16 to 18, 1918. Length on Load Waterline, 600 Feet; Beam, 97.156 Feet; Draft, mean, 30.823 Feet; Displacement, 32,911 Tons; Diameter of Propeller, 13 Feet 5 Inches; Pitch of Propeller, 15 Feet 2 Inches; Ratio Projected Area to Disk Area, 0.3562; Number of Blades, 3; Number of Propellers, 4; Scale of Model, 1/30 Full Size.

speed of 18.95 knots may be in error either in the torsion meter reading, in the speed over the course, or in both. Possibly, also, the power difference may result from erratic steering during the trial of the ship, or insufficient run to attain uniform speed before starting on the measured mile. There is no information, however, in the trial report which would bear out this assumption. It should be noted also that at the lower speeds there is some doubt as to the accuracy of the calibration of the electrical meters used for measuring the power input to the motor.

In estimating the shaft horsepower for the ship, the effective horsepower for the model with full appendages,

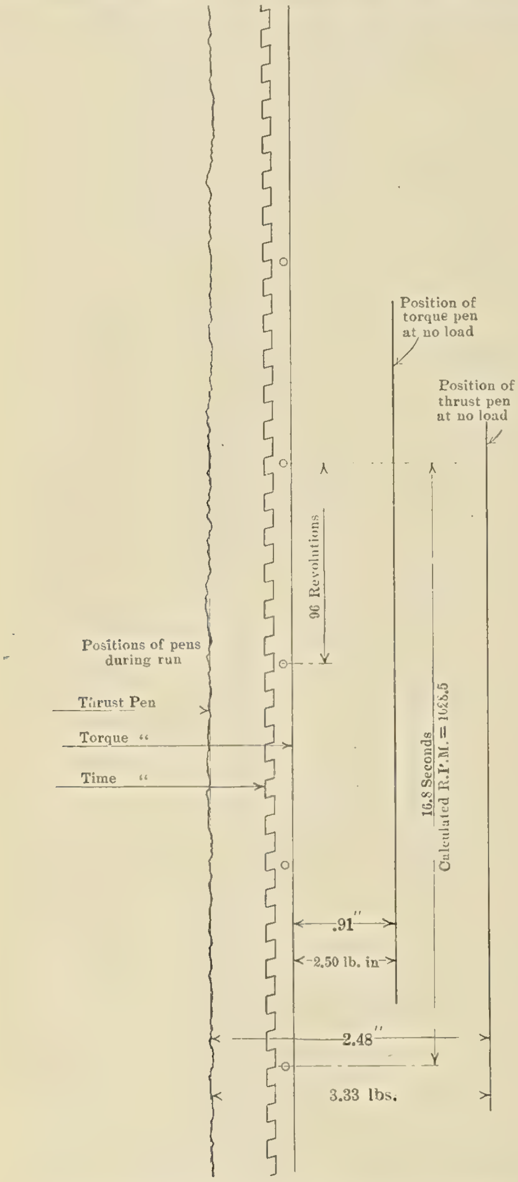

Fig. 4.—Dynamometer Card, Showing Propeller Thrust, Torque and Revolutions per Minute

as determined in the Model Basin tests dated September 9, 1915, was used. This effective horsepower curve does not take into consideration the resistance of the paravane gear which was rigged on the ship during the trials. From the fact that the shaft horsepower estimated from the Model Basin tests and the revolutions per minute are in close agreement with the results obtained on the trials of the ship, it is apparent that either the paravane gear did not add much to the ship's resistance, or that the effective horsepower originally estimated for the ship was high by an amount equivalent to the resistance of the paravane gear.

The average wake factor for the four propellers at a ship speed of 21 knots was found to be .15, with 16 percent apparent slip and 29 percent true slip. With the total power on the model distributed equally between the four shafts, it was found that the outboard shafts ran at about 1 percent higher revolutions per minute than the inboard shafts. The propulsive coefficient is 65.3 percent at 21 knots with a hull efficiency of 100 percent, indicating that the arrangement of shafting, struts and hull clearances for the propellers are very good.

Another conclusion from the investigation and from other similar tests is that the Model Basin method of testing with model propellers fitted to drive a model of a ship may be used with confidence to predict the performance of the ship on trials. There is a limitation, however, in the case of propellers which on the ship are running in the cavitating region, in which event cavitation may be experienced on the ship and not occur on the model.

In addition to the work of this character already done on models of naval vessels, several progressive private shipbuilding interests of the country have been quick to see the advantages of self-propulsion model tests and have arranged to have such tests made on the models of proposed new merchant ships. The law under which the Model Basin was established provides that private shipbuilding companies may have models tested on payment of the actual cost of the work to the Government.

The present cost for making a 20-foot model and testing it for resistance at three or four different conditions of draft is $500 (104/3/4). From these tests the corresponding effective horsepower curves for the ship are computed and given in the report of test. The additional charge for fitting shafts and propellers to the model and making self-propulsion tests in the case of a twin-screw ship is about $300 (62/10/0).

From the latter tests the shaft horsepower, revolutions per minute and propulsive coefficient for the ship at different speeds are estimated and given in the report.

Japanese Shipbuilding in 1919

A REVIEW of Japanese shipbuilding during 1919 published in the *Japan Chronicle* states that the industry was unexpectedly prosperous during 1919, the ships of over 1,000 tons in displacement launched numbering 134, aggregating 619,558 tons. As compared with the previous year, the figures show a decrease of 55 in the number of ships, but an increase of 40,750 in tonnage, showing thereby the construction of comparatively larger ships during the year. Below are given further particulars classified according to different yards:

Yards	Number	Tonnage
Kawasaki	34	196,537
Asano	12	74,270
Uraga	9	45,870
Mitsubishi	11	67,523
Harima	6	33,860
Osaka Ironworks	16	96,000
Ishikawajima	5	12,164
Toba	5	8,550
Nitta	4	6,173
Yokohama	4	15,080
Uchida	3	10,100
Aizawa	3	3,600
Naniwa	2	4,000
Mitsui	3	14,100
Yoshiura	2	3,800
Fujinaga	2	4,450
Toyo Inds. Company	1	1,420
Ono Iron Works	1	2,250
Harada	1	1,300
Kizukawa	1	1,850
Osaka Cer. Company	1	2,200
Asahi	1	3,800
Horikawa	1	1,200
Sanyo Iron Works	1	1,192
Hashimoto	1	2,030
Matsuo Iron Works	2	4,230
Kyushu	1	1,250
Hakodate	1	1,600

Preventing Corrosion in Marine Boilers

BY E. N. SPELLER*, E. G. BASHORE†, ISAAC HARTER†† AND W. W. SMITH‡

This article on the control of corrosion in marine boilers has been prepared as a guide to marine engineers. It is based on what is believed to be the best practical experience. The preparation of these notes was suggested from an investigation of recent disastrous results in tubes in marine boilers where no attention was paid to water treatment.

THE basic causes of corrosion are better understood than they were some time ago, so that it is now possible to figure out and apply the treatment required, so as to keep the boiler water in a relatively harmless condition with some degree of certainty. The treatment described, employs only soda ash and lime—both well known and easy to obtain commercially in a sufficiently pure condition. However, it is recommended that the supply be obtained from reputable dealers under a guarantee. The result of using compounds of unknown composition is uncertain and sometimes harmful.

Treatment of Boiler Feed Water

While it is better practice, as a rule, to treat boiler water before filling the boilers, this is not practicable or effective in the case of marine boilers, on account of the weight and space occupied by a treating plant, and more particularly because the contamination is almost entirely due to leakage of sea water into the boiler system. Furthermore, a good supply of boiler water can usually be obtained, and, of course, the best should be selected, as the less the amount of chemicals added to the boiler the better.

Most natural waters, particularly those which are very pure, are corrosive, so that the instructions as to treatment of new boiler water should be noted and carefully followed, for rust once started often propagates itself, as it were, at a most alarming rate. After the first additions a certain limited degree of alkalinity should be maintained to take care of a reasonable amount of salt-water leakage. An excess of alkalinity is harmful, therefore the maintenance of the water in the boilers in the best condition, all things considered, depends primarily on a daily system of testing and records.

In preparing these notes all mention or discussion of the chemistry of the reactions which take place in boilers has been purposely avoided. The procedure has been defined in practical terms for the use of assistant engineers in their daily routine.**

Causes of Corrosion in Boilers

The principal causes of corrosion and pitting in marine boilers may be classified as due to:

(1) Air in the feed water.
(2) Organic or fatty acids from greases and oils.
(3) Presence of sea water.

(1) The oxygen component of air is somewhat soluble in water, and in this form promotes rapid corrosion. The exact mechanism of corrosion through the agency of dissolved oxygen need not be explained, since this particular point involves certain theories concerning which there is a variance of opinion. The fact remains that oxygen dissolved from air by water is probably the greatest accelerator of corrosive action and should be removed.

(2) Organic acids find their way into the feed-water system, in lubricants compounded with animal or vegetable oils. The decomposition of compounded lubricants takes place in a manner similar to that in which a fat is decomposed by soapmakers with the liberation of glycerine and fatty acids. The glycerine dissolves in the water, and the fatty acids are free to attack the metal parts of the boiler.

(3) Sea water is in part made up of the constituents shown in the following average representative analysis:

Calcium sulphate	70	grains per U. S. gallon
Magnesium sulphate	130	" " "
Magnesium chloride	140	" " "
Sodium chloride	1,700	" " "

The magnesium chloride is the most harmful component, for, under the influence of temperature and pressure in the boiler, this salt dissociates into hydrochloric acid and magnesium hydrate; the acid, in contact with the iron, forms iron chloride, which, in turn, reacts with the free magnesium hydrate in the water, thereby precipitating hydrate of iron and re-forming magnesium chloride. This cycle of reactions is repeated, so that a small amount of magnesium chloride is capable of doing serious damage. Under certain conditions magnesium sulphate is also decomposed in the same way into magnesium hydrate and sulphuric acid, but this reaction does not take place to the same extent as with magnesium chloride.

General Methods of Preventing Corrosion

Having discussed in a general way the three main causes of corrosive action common to marine boilers, the means of prevention will be discussed in the same order of sequence:

(1) As previously stated, the oxygen component of air is somewhat soluble in water, and in this form promotes rapid corrosion. Solubility of oxygen increases with pressure increase and decreases with temperature increase. These factors governing the relative degree of solubility of oxygen in water suggest the following means for prevention of corrosion:

- (a) Heating the water in the boiler under atmospheric pressure by means of circulators, or in the absence of circulators, by boiling the water for a short time under atmospheric pressure by means of direct fire, before closing up the boilers.
- (b) Keeping the water in the feed-water tank at the highest practicable temperature with least surface exposed to air.

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** Those who care to study the chemistry of boiler water treatment are recommended to secure and read copies of the following:

Naval Standard Boiler Testing Outfit, Bureau of Steam Engineering, Washington, D. C.

The Reports of the Committee on Water Service of the American Railway Engineering and Maintenance of Way Association, which give methods of water softening and of analytical control.

"Boiler Feed Water," by Anderson. (D. Van Nostrand Company, New York).

"Purification of Water for Use in Steam Boilers," J. O. Handy, Proceedings of Engineers' Society of Western Pennsylvania, January, 1899.

"Boiler Waters; Their Chemical Composition, Use and Treatments," by W. T. Read, University of Texas Bulletin No. 1752, Austin, Texas.

(c) Keeping the pump glands in suction joints tight to avoid drawing in air. All feed-pump suctions should be entirely covered with water at all times.

(d) Filling the available space in the feed-water tank with steel-metal lathing. This will fix the remaining traces of free oxygen by a rusting action on the surface of the lathing thus exposed.

(2) Since it is the animal or vegetable constituent which is responsible for the corrosive action by lubricating oils, the best means of prevention is to use only oils having a pure mineral base, and not compounded oils. It should be borne in mind that it is more important to protect the boilers from the possibility of acid attack than to obtain perfect internal lubrication. The precaution of purchasing only mineral oils for lubrication is to be emphasized not only from the corrosion standpoint, but because such oils prevent wet steam formation through foaming. Fatty acids combine with alkalies to form soluble soaps, and obviously soap dissolved in boiler water would lead to a condition of severe foaming.

(3) The statement has been made that sea water is corrosive, because of the decomposition of its magnesium chloride component at high temperature and pressure. Magnesium chloride may contaminate the feed-water supply through sea-water introduced from four possible sources:

(a) Condenser leakage.
(b) Inter-communicating valve leakage.
(c) Steam heaters of salt water.
(d) Leakage or priming of evaporators.

Magnesium chloride corrosion may be prevented in two ways:

(a) By avoiding the introduction or leakage of any sea water into the feed-water system, from any of the sources enumerated in the foregoing.
(b) By chemical neutralization.

Magnesium chloride can be neutralized by soda ash, and in this system the sodium chloride, or common salt, content of the water is taken as the measure of the quantity of soda ash required for neutralization of the magnesium chloride, which is also present.

Special Safeguards Against All of the Causes of Corrosion Combined

Special safeguards against all of the causes of corrosion combined may be classified under two headings:

(1) Lime addition to the water in the boiler.
(2) Maintenance of alkaline water in the boiler by periodic additions of soda ash.

(1) The reason for the use of lime is the conversion of magnesium chloride into magnesium hydrate and calcium chloride, neither of which is corrosive; and, more especially, the formation of a light scale on the surface of metal, thus preventing the corrosive elements from coming in contact with the iron.

When starting with new boilers on a voyage for the first time, after thorough cleaning,* ten pounds of lime (dissolved in cold water and run in through manhole) should be put into the boilers for every 30,000 pounds water capacity, and four to six pounds of lime per day for every 30,000 pounds water capacity should be passed through the hot well (as milk of lime) for about six days. Milk of lime is a mixture of about one pound of unslaked lime, or 1⅓ pounds of hydrated lime, with a gallon of water. Lime additions are to be made only when the boilers are new or after retubing.

(2) The fact has been established that by maintaining alkaline water in the boiler the tendency towards corrosion is greatly lessened. Certain purely theoretical considerations support this statement; however, for the object at hand a simple statement of fact is sufficient.

The limit of the amount of this alkalinity has been purposely fixed at 15 grains per gallon. This means excess soda ash to the extent of 15 grains per gallon over and

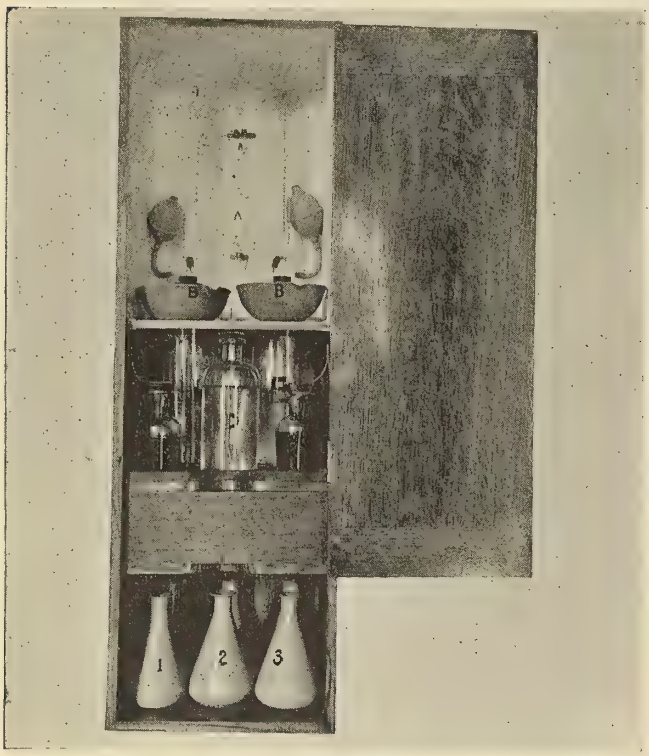

Fig. 1.—Testing Kit

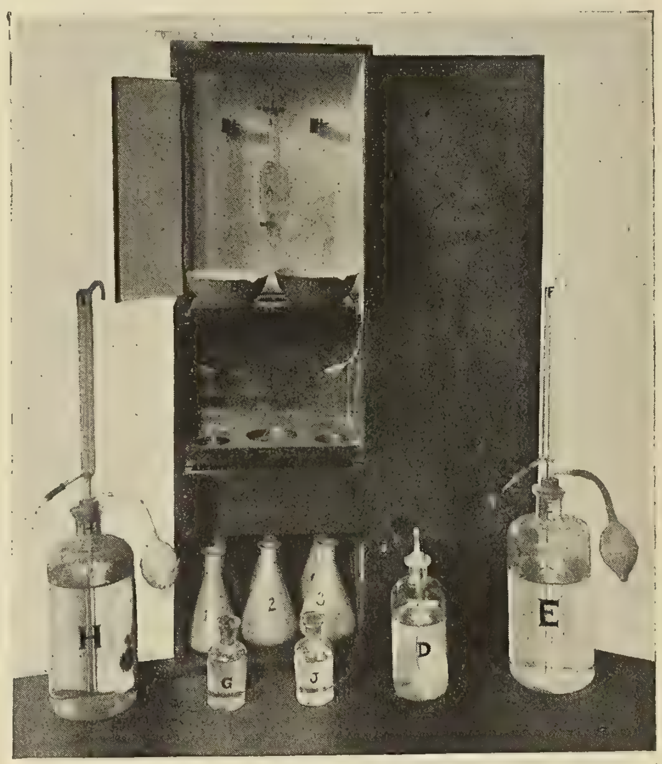

Fig. 2.—Testing Kit Ready for Use

* See section dealing with "General Practice," page 426.

above the amount necessary to combine with the magnesium chloride (and other scale-forming) components of the water. While 15 grains of excess alkalinity is stated as the desirable amount, it is recognized as impracticable for the operator in charge regularly and consistently to carry the prescribed 15 grains. For this reason it is better to work between the limits of 10 and 20 grains, and to try in so far as possible to aim at an excess alkalinity figure of 15 grains. While water is improved from a corrosion prevention standpoint through the agency of excess alkalinity, on the other hand too great an excess would be liable to bring about dangerous operating conditions through the embrittling of the steel in the boilers. Therefore, the importance of establishing and maintaining a limited degree of excess alkalinity is to be emphasized; the safe limits lie between 10 and 20 grains per gallon.

It is desirable to call attention to the distinction between the two uses of soda ash, namely, the one use of maintaining alkaline water in the boilers, and the other use of bringing about a neutralization of the magnesium chloride content of the water.

In the first case the soda ash is intended to remain uncombined; and if no substances are present with which it can react, then one addition would be sufficient. In the case of salt water leakage in the boilers, however, the additions must be repeated as long as magnesium chloride is being added to the system. Both objects are accomplished and controlled through the use of the testing kit described below.

Operation of the Testing Kit

The testing kit consists of the assembled glass apparatus and reagent bottles as shown in Figs. 1 and 2. Each glass container is marked with an identifying letter, and the letters follow in sequence of the different operations in conducting the test.

It is suggested that the instructions for conducting the tests be carefully read over, and then the actual manipulations be tried, using pure or distilled water until the operator becomes thoroughly familiar with the color changes which take place. In the actual determination on samples, which are to be reported on the log sheet, time must be allowed for the cooling of the sample to the room temperature before conducting the test.

It is necessary to have a definite volume of test water to start with. A sample should be taken in a glass receptacle which has been thoroughly washed out with the water to be tested.

(*A*).—For this purpose the measuring pipette *A* is provided. Fill the 50 cubic centimeter pipette *A* with the boiler water by gentle suction with the mouth to a point slightly beyond the scratch mark on the stem of the pipette, holding the charge of water in the pipette through pressure applied at the suction end with aid of the index finger. Now gently release the pressure until the water drops to the scratch mark level.

(*B*).—Deliver the unit charge of water thus taken to the white porcelain dish marked *B*.

(*C*).—With pipette *C* manipulated in the same manner as described under (*A*). Fill exactly to the scratch mark on pipette *C* with the solution in the bottle marked *D*. A piece of rubber tubing supplied with the kit may be put over the suction provided any difficulty is experienced in filling to the scratch mark.

(*D*).—The exact quantity of solution *D* should then be added to the water sample contained in porcelain dish *B*.

(*E*).—Now transfer the solution from large bottle *E* by gently blowing in the rubber tubing connected with the bottle through the double hole rubber stopper so that solution *E* passes into burette *F*.

(*F*).—Continue the pressure until the level of the solution in *F* is a little higher than the outlet to the fixed level elbow bend at the top of *F*. By releasing the pressure the solution should flow back so that the level stands at a fixed position at the top of *F* located by red graduation mark 5. It is absolutely essential that the volume of solution in *F* be brought to the constant level as shown by red graduation mark 5, otherwise the results will be in error. Having filled burette *F* in the manner described, the next step is to color the sample of water in the porcelain dish *B* with an indicator for this purpose.

(*G*).—Five drops of solution *G* is added to the water sample in *B*. This quantity of indicator *G* should be sufficient to color the water a light orange or straw color. Now by applying pressure with the thumb and index finger on the rubber around the tit outlet, to burette *F*, the solution in *F* can be dropped gradually into water sample in *B*. Fig. 3 illustrates the principle involved.

Continue the dropping of solution contained in burette *F* into water in *B*, meanwhile stirring constantly with a glass rod provided with the kit, until there occurs a change in color from a light yellow-orange to a red color.

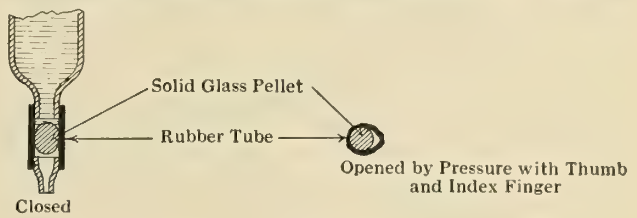

Fig. 3

At the instant this color change takes place, stop any further addition from burette *F* and immediately take the reading on the burette. This reading is recorded on the log sheet as *F*.

This reading should be a white-line graduation reading and preferably around the graduation 15, indicating 15 grains of alkalinity in terms of soda ash per gallon of water.

This completes the determination of the alkaline (or acid) condition of the boilers, and the next step is to test for the quantity of salt in the boilers. Interchange the position of *B* dishes, carefully moving the one containing the sample under the second burette, then drop by drop with constant stirring add solution *D* from pipette *C* until the red color again changes back to a yellow orange. Usually one to two drops of solution *D* will be sufficient for this change.

(*H*).—The solution *H* should be forced over into burette *I*.

(*I*).—Forcing the solution into burette *I* should be done in a manner similar to that employed in filling the first burette.

Care should be taken not to overflow the side outlet tube, at the same time remembering that it is absolutely essential that the solution be brought to the top constant level device, and at a level in line with the zero reading. After *I* has been filled, the next step is to add five drops of indicator *J*.

(*J*).—The addition of five drops of indicator *J* will not cause a very noticeable change in the color of the solution. Now pressing the rubber pinch cock at the outlet of *I*, drop the solution into porcelain dish *B*, constantly stirring the sample in *B*, and continue the dropping until the color of the body of liquid changes from an orange yellow to a red color. On the first addition of the solution a white curdy precipitate will form, but this in no way will interfere with the final red color. The moment this

change takes place stop the addition of solution from I and note the reading on the burette I.

The reading I should preferably be below the 100 graduation mark, which would be an indication that the boilers were carrying less than 100 grains per gallon of sodium chloride (salt). The burette I is graduated so that the smallest subdivision is equivalent to 10 grains per gallon. Provided the reading I happened to come to the first division below the 200, then the proper entry for I reading would be 210 grains of sodium chloride (salt) per gallon. Entry of the I reading should be made at the proper place provided for the same on the log sheet.

(K).—The K number indicates the increase in grains per gallon of sodium chloride over a certain period of time (preferable 24 hours), and therefore is arrived at by subtracting the previous log reading from the present log reading. In other words, assume that the water sample on starting the boilers showed an I_1 reading of 10 grains per gallon of sodium chloride (and this had already been treated for in a manner which will be described later); and on the next 24-hour period the I_2 reading gave 30 grains per gallon, then 10, the previous I_1 reading, subtracted from 30, the present I_2 reading, gives K number 20.

Sampling, Soda Ash Additions, and Log Records

It is advisable to sample and treat each boiler individually, for the reason that the water in different boilers will vary, and it is the water condition of each boiler which determines whether, or not, that particular boiler is liable to corrosion.

In conducting the tests and administering the soda ash treatment, it is to be recommended that a twenty-four-hour period be established as the working basis. All of the engineering officers should have a working knowledge of the details of the method, but the second assistant engineer aboard the ship should be held directly and specifically responsible for the fulfillment of the duties as set forth.

Samples shall be taken from the salinometer cock or from a special valve directly connected to the shell of each boiler every twenty-four hours, and the readings as the result of testing each water sample entered on the log sheet at the time the tests are made.

The proper amount of soda ash to be added to each boiler over a twenty-four-hour period is determined by the K number. The K number indicates the *increase of sodium chloride* in comparison with the previous twenty-four-hour period, and therefore is arrived at by subtracting the previous I_1 reading from the present twenty-four-hour period I_2 reading. The amount of soda ash corresponding to the K number will naturally vary, depending upon the water capacity of each boiler.

Tabulated sheets follow giving the requisite amount of soda ash for corresponding K numbers covering boiler water capacities of each boiler from 10,000 to 19,000 pounds. After having conducted the test, and thereby determined the K number, the corresponding quantity of soda ash required for the particular boiler in question should be added to a suitable tank and put into solution through the addition of ten to twenty gallons of water, at the same time stirring until completely dissolved, then feed to the particular boiler to which the addition is to be made, by introducing the solution through the suction end of the auxiliary feed pump.

Daily tests of water from the feed tank should be made in the same way. This water will normally be neutral and free from more than a trace of chlorides. Should the I_2 reading be higher than I_1, to any extent in the feed tank sample, and a high K number is found on the boiler samples, the source of the leak should be found and should receive attention as soon as possible. Should the K number in the boiler samples be insignificant under these conditions, the chlorides in the feed water probably came from foaming in one or more of the boilers. With a little experience the engineer will be able to use these means to trace the origin of other leakages.

A facsimile of the form to be used in reporting the tests is shown below, and at the end of the article will be found the tabulation of the required number of pounds of soda ash corresponding to the K number, covering a range of from 10,000 pounds to 19,000 pounds boiler water capacity.

BOILER WATER TEST LOG

Ship ....
Time..............A. M. or P. M.
Date ....
Tested by ....

	Boilers 1	2	3	4	5	6		Feed Tank
Water capacity of each boiler....								
F—Reading (red line)...........								
F—Reading (white line)..........								
I_2 Reading (present I reading)..								
I_1 Reading (present I reading)..								
K—number $= I_2 - I_1$..........								
Water capacity of each boiler....								
Soda ash added—pounds.........								
Time added								

Note.—If the F reading falls within the red lines this indicates an acid condition of water, which is extremely dangerous.

Rule for Soda Ash.—The K number indicates the increase of sodium chloride in comparison with the previous boiler-water test log, and therefore is arrived at by subtracting the previous log reading (I_2) from the present log reading I_1. Refer to the tabulation corresponding to the water capacity, and from the above K number note the required amount of soda ash directly opposite.

Maintaining the Proper Degree of Alkalinity

The method of determining the proper amount of soda ash has been outlined in detail; however, nothing has been said with regard to maintaining the proper degree of alkalinity—15 grains per gallon—within the water system. Attention is called to the fact that the required amount of soda ash corresponding to the K number takes care only of the fresh sea water, which has found its way into the system and does not allow for the excess (15 grains per gallon) which is desirable. This is readily calculated, and below is shown the pounds of soda ash equivalent to 15 grains per gallon in excess for the total water capacity of the ship's system, varying from 50,000 to 150,000 pounds:

Water Capacity—Pounds	Pounds of Soda Ash Required to Give an Excess of 15 Grains Per Gallon
50,000	13
60,000	16
70,000	18
80,000	21
90,000	23
100,000	26
110,000	28
120,000	31
130,000	33
140,000	36
150,000	38

When starting the boilers with fresh water for the first time, the amount of soda ash to be added to the water system is determined by the total water capacity of the ship's system. This soda ash treatment should not be started until the lime additions referred to on page 422 paragraph (1), are completed. If, for example, the total water capacity happens to be 60,000 pounds, then by referring to the foregoing tabulation the amount of soda ash to be added to the system would be 16 pounds, or with a water capacity of 120,000 pounds the amount of soda ash would be 31 pounds. After making the requisite addition of soda ash, and allowing time for complete solution and distribution through the system, the correctness of the amount should be checked through the taking of a sample of water and testing for alkalinity. The reading should give between 10 and 20 grains per gallon of alkalinity in each boiler.

10,000 POUNDS WATER CAPACITY

K Number	Pounds Soda Ash to Be Added	K Number	Pounds Soda Ash to Be Added
10	.37	160	6.00
20	.75	170	6.37
30	1.12	180	6.75
40	1.50	190	7.12
50	1.87	200	7.50
60	2.25	210	7.87
70	2.62	220	8.25
80	3.00	230	8.62
90	3.37	240	9.00
100	3.75	250	9.37
110	4.12	260	9.75
120	4.50	270	10.12
130	4.87	280	10.50
140	5.25	290	10.87
150	5.62	300	11.25

11,000 POUNDS WATER CAPACITY

K Number	Pounds Soda Ash to Be Added	K Number	Pounds Soda Ash to Be Added
10	.413	160	6.61
20	.83	170	7.02
30	1.24	180	7.43
40	1.65	190	8.26
50	2.06	200	8.67
60	2.48	210	9.08
70	2.89	220	9.50
80	3.30	230	9.91
90	3.72	240	10.32
100	4.13	250	10.73
110	4.54	260	11.15
120	4.96	270	11.56
130	5.37	280	11.97
140	5.78	290	12.39
150	6.19	300	

12,000 POUNDS WATER CAPACITY

K Number	Pounds Soda Ash to Be Added	K Number	Pounds Soda Ash to Be Added
10	.451	160	7.22
20	.90	170	7.67
30	1.35	180	8.12
40	1.80	190	8.57
50	2.25	200	9.02
60	2.71	210	9.47
70	3.16	220	9.92
80	3.61	230	10.37
90	4.06	240	10.82
100	4.51	250	11.27
110	4.96	260	11.72
120	5.41	270	12.17
130	5.86	280	12.63
140	6.31	290	13.08
150	6.76	300	13.53

13,000 POUNDS WATER CAPACITY

K Number	Pounds Soda Ash to Be Added	K Number	Pounds Soda Ash to Be Added
10	.489	160	7.82
20	.98	170	8.31
30	1.47	180	8.80
40	1.96	190	9.29
50	2.45	200	9.78
60	2.93	210	10.27
70	3.42	220	10.76
80	3.91	230	11.25
90	4.40	240	11.73
100	4.89	250	12.22
110	5.38	260	12.71
120	5.87	270	13.20
130	6.36	280	13.69
140	6.85	290	14.18
150	7.33	300	14.67

14,000 POUNDS WATER CAPACITY

K Number	Pounds Soda Ash to Be Added	K Number	Pounds Soda Ash to Be Added
10	.527	160	8.43
20	1.05	170	8.96
30	1.58	180	9.49
40	2.11	190	10.01
50	2.63	200	10.54
60	3.16	210	11.07
70	3.69	220	11.60
80	4.21	230	12.12
90	4.74	240	12.65
100	5.27	250	13.17
110	5.80	260	13.70
120	6.32	270	14.23
130	6.85	280	14.76
140	7.38	290	15.28
150	7.91	300	15.81

15,000 POUNDS WATER CAPACITY

K Number	Pounds Soda Ash to Be Added	K Number	Pounds Soda Ash to Be Added
10	.565	160	9.04
20	1.13	170	9.60
30	1.69	180	10.17
40	2.26	190	10.73
50	2.82	200	11.30
60	3.39	210	11.86
70	3.95	220	12.43
80	4.52	230	13.00
90	5.08	240	13.56
100	5.65	250	14.12
110	6.22	260	14.69
120	6.78	270	15.25
130	7.35	280	15.82
140	7.91	290	16.38
150	8.48	300	16.95

16,000 POUNDS WATER CAPACITY

K Number	Pounds Soda Ash to Be Added	K Number	Pounds Soda Ash to Be Added
10	.603	160	9.65
20	1.21	170	10.25
30	1.81	180	10.85
40	2.41	190	11.45
50	3.01	200	12.06
60	3.62	210	12.66
70	4.22	220	13.26
80	4.82	230	13.87
90	5.43	240	14.47
100	6.03	250	15.07
110	6.63	260	15.68
120	7.23	270	16.28
130	7.84	280	16.88
140	8.44	290	17.48
150	9.04	300	18.09

17,000 POUNDS WATER CAPACITY

K Number	Pounds Soda Ash to Be Added	K Number	Pounds Soda Ash to Be Added
10	.641	160	10.25
20	1.28	170	10.90
30	1.92	180	11.54
40	2.56	190	12.18
50	3.21	200	12.82
60	3.85	210	13.46
70	4.49	220	14.10
80	5.13	230	14.74
90	5.77	240	15.38
100	6.41	250	16.02
110	7.05	260	16.66
120	7.69	270	17.30
130	8.33	280	17.95
140	8.97	290	18.59
150	9.61	300	19.23

18,000 POUNDS WATER CAPACITY

K Number	Pounds Soda Ash to Be Added	K Number	Pounds Soda Ash to Be Added
10	.679	160	10.86
20	1.36	170	11.54
30	2.04	180	12.22
40	2.72	190	12.90
50	3.40	200	13.58
60	4.07	210	14.26
70	4.75	220	14.94
80	5.43	230	15.62
90	6.11	240	16.30
100	6.79	250	16.97
110	7.47	260	17.65
120	8.15	270	18.33
130	8.83	280	19.01
140	9.51	290	19.69
150	10.18	300	20.37

19,000 POUNDS WATER CAPACITY

K Number	Pounds Soda Ash to Be Added	K Number	Pounds Soda Ash to Be Added
10	.717	160	11.47
20	1.43	170	12.19
30	2.15	180	12.90
40	2.87	190	13.62
50	3.58	200	14.34
60	4.30	210	15.05
70	5.02	220	15.77
80	5.74	230	16.49
90	6.45	240	17.21
100	7.17	250	17.92
110	7.89	260	18.64
120	8.60	270	19.36
130	9.32	280	20.08
140	10.04	290	20.79
150	10.75	300	21.51

Case Where the Water is Slightly Acid

One possible case which has not been discussed is where the water is slightly acid, or in other words gives an *F* reading within the red-line marks of burette *F*. In such a case, obviously the water has used up the excess alkalinity, and therefore, in addition to the soda ash required by the *K* number, an amount must be added equal to the quantity shown for the corresponding water capacity, plus an additional amount proportionate to the acidity.

In event it becomes necessary to blow down the boilers and use makeup water in addition, the only complication this condition adds to the method is, that it becomes necessary for the engineer to estimate the quantity of makeup water to be added to the system. Having estimated the quantity of makeup water required, by referring to the tabulation it is a matter of simple division and multiplication to estimate the requisite amount of soda ash to be added in order to establish a condition of 15 grains per gallon of alkalinity.

Should the feed tank sample or the boiler water samples consistently show an alkalinity several grains below the 15 mark, say around 5 or 7, then it would be advisable to increase the soda ash additions as indicated by the *K*

number. In this case, care should be taken not to overdose the boilers, remembering that 20 grains per gallon of alkalinity should not be exceeded, and that 15 grains is the desired amount.

General Practice

In discussing boiler operation from the feed-water standpoint, it is necessary to consider the accessories to the boiler as well as the boiler itself.

Every effort should be made to keep the condensers tight and prevent any leakage of salt water to the feed system. Whenever the tubes of condensers are found to be leaking, steps should be taken without delay to locate and stop such leaks and prevent the admission of salt water to the boilers.

The boiler-feed pump should not be used for other purposes than those connected with the service of the boiler or feed water, except in cases of emergency. When not under steam their piston and valve gears should be moved every day.

The interior of the evaporators should be examined, and the tubes or coils cleaned and scaled at as frequent intervals as practicable. When an evaporator is not required for use for several days the shell and coils or tubes should be drained and kept dry until needed for service.

Boilers which are to be idle for a considerable length of time should be emptied, and their interiors should be thoroughly dried. Open trays of as large capacity as practicable should be filled to about half their height with quicklime, which in turn should be introduced through the manhole into the drum of the boilers. The boilers should then be closed airtight, and special precautions taken to prevent any moisture entering the interiors while they are being thus treated.

During the construction and installation of boilers, more or less grease finds its way into the plates and tubes. This condition should be taken care of by adding soda ash to the water and boiling out for a period of at least 48 hours. After emptying the boilers they should be thoroughly washed with a hose carrying water at high pressure.

Progressive Ship Construction

In order to overcome what are considered to be wastes in the efficiency of space and equipment utilization in the shipyards, Roberto Gallazzi, of the S. A. I. Gio, Ansaldo and Company, Genoa, Italy, has developed a method of ship production designed to speed up operations.

The idea is in effect the application of the same principles to the construction of large ships as were utilized in building the "Eagle" type submarine chasers in the Ford plant during the war. Instead, however, of the various fabricating processes being carried out while the boat progresses from one station to another on trucks, the new system provides a channel in which the partly constructed hull floats. On either side of this channel are shops from which the assembled plates, fittings, machinery and other equipment are installed in the vessels.

The recommendations for such a system of ship fabrication seem to be the division of labor and the reduction of material handling, as well as the elimination of building ways and the duplication of crane and other equipment. The present wet dock for fitting out ships is really a limited application of the idea.

Application of Method to Cargo Boats

For freighters of 8,000 tons deadweight, the building channel, as it is called, occupying the central part of the yard, is about 60 feet wide and 2,500 feet long. The height of the ground level above the water level is about 11 feet. From the ground level the depth of the channel in different sections, corresponding to six stages in the construction of a vessel, is, in the first section, which is a dry dock, about 23 feet, and in the other five sections 19, 20, 21, 22, and 25 feet respectively.

In the dry dock section the hull is commenced and built up sufficiently to carry the stresses when the ship is

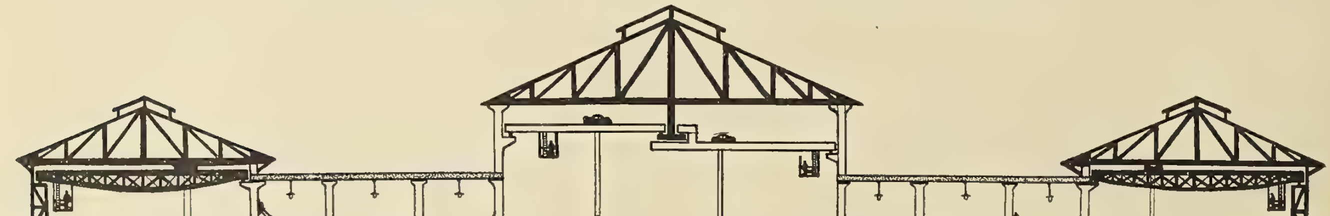

Fig. 1.—Perspective Sketch of Proposed Shipyard for Progressive Construction

Fig. 2.—Section Through Yard at First Stage, Showing Material Storage Space, Fabricating Shops and Building Berth

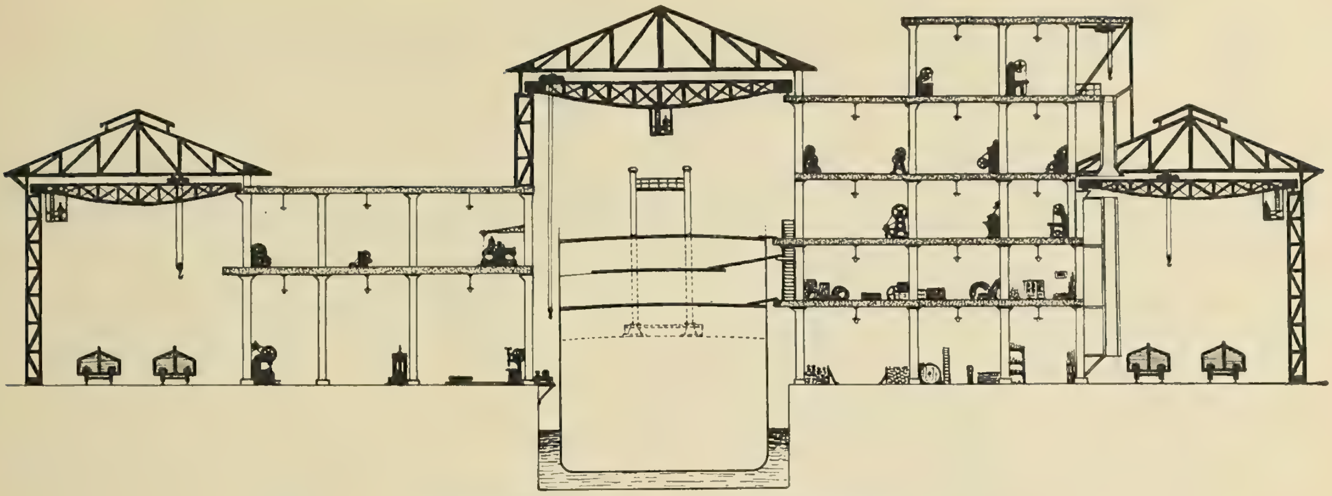

Fig. 3.—Section Through Yard at Fitting-Out Berth

floated. A double bottom, floors, main frames, lower deck beams, outer plating to the lower deck, keelsons, stringers, transverse bulkheads, are all assembled at this stage and part of the painting done. The water is then admitted to the dry dock and the partially built hull floated and towed to the second section. In this section the plating is completed, longitudinal bulkheads and stringers fitted, upper tanks installed and more of the painting completed, after which the ship advances to the next station. Superstructure, hatchways, ventilators and the like are fitted here. At the next three stations the machinery, deck fittings, distiller, joiner work, rigging, carpenter work, electrical equipment, anchors, chains, lifeboats, etc., are installed and the ship is ready for her trials.

At each station the shops are arranged so that material is handled in an efficient manner.

Waterfront Development in Winter at Northern Ports

BY H. MC L. HARDING*

FROM experience lately gained in the construction of the new port works of the city of Milwaukee, Wis., it has been ascertained not only that the work can be continued during the winter months, but that it can be carried on more rapidly and at even a less cost than during the summer.

In the driving of piles, the placing of timber and the installing of various terminal facilities, which has always been considered difficult, if not almost impossible, during severe cold weather, the work has now been found easy—in fact, it has been more advantageously done in winter than at other times. Hitherto the usual custom has been to shut down until spring.

At Milwaukee, along the inner shore of Jones Island, there is being built about 1,600 feet of quay construction consisting of the driving of rows of vertical and batter piles and attaching longitudinal and other timbers to these piles. The depth of the water near the shore, especially where the inner rows of vertical and batter piles are being driven, varied from one to three feet. This section is later to be filled with earth.

In the summer it would have been necessary to have dredged sufficiently deep to bring the scow supporting the pile-driving machinery close to the shore or else to have erected false work along or near the bank. Either of these methods would have been expensive and have consumed much time in preparation.

During this winter for an average distance of some seventy feet from the shore the ice was frozen some two feet in thickness, and when the water was less than two feet in depth the earth under the ice was also frozen.

It was suggested that some 12-foot by 12-inch timbers be laid upon the ice and upon these rollers, and on these rollers be placed the framework of pile drivers and the house containing the winches, the boilers and other accessories.

With a bar a small hole a few inches deep was started in the ice, and by means of a steam jet from the boiler in about five or six minutes a hole in the ice was made and enlarged and the frozen earth beneath was sufficiently softened so that the vertical and batter piles could be freely and easily driven. After this driving the alinement, not only of the vertical but also of the 30-degree batter piles, was so perfect that it was impossible to detect any variation from a straight line.

After the several rows of piles were driven the longitudinal and other timbers were placed in position, the cutting for these in the ice was also carried on from the surface of the ice. The steam jet apparatus consisted of a flexible-armored hose with a pipe one inch in diameter bent at right angles.

It was estimated from the progress already made that the number of piles driven in a day through the ice was about double that which would have been possible in summer from the floating scow.

The winches for operating grab buckets were sheltered in the movable houses and similarly were moved to and fro upon timbers on the ice where desired. The men, even those occupied outside the houses, could keep warm by going for a few minutes into the boiler houses. There were intervals during the driving of the 60-foot piles when the men were more comfortable than when working in the cold water during the spring and fall. The lost days due to inclement weather were not more than during the other seasons.

It is a source of much gratification that the waterfront development of northern ports is not to be suspended in such cases during the winter, and that the work can be continued, the men continuously employed, and even better progress made. This possibility of winter construction is of great value on the upper Mississippi and other northern rivers, and at other ports than Milwaukee of the Great Lakes, where construction has generally ceased upon the advent of cold weather.

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Cramp's Floating Machine Shop

BY LOUIS P. MAIER*

A NUMBER of shipyards along the Atlantic coast have floating repair shops, but for compactness, combined with the large variety of work that can be done at one time, the floating machine shop designed, built and operated by the Kensington shipyard department of the William Cramp and Sons Ship and Engine Building Company, of Philadelphia, Pa., is in a class by itself.

Soon after the war started the management of the Cramp Company realized the need of providing some adequate means for expediting the work of repairing the various transports coming to the port of Philadelphia for taking on board troops and supplies. The shipyard was situated about three miles from the government piers;

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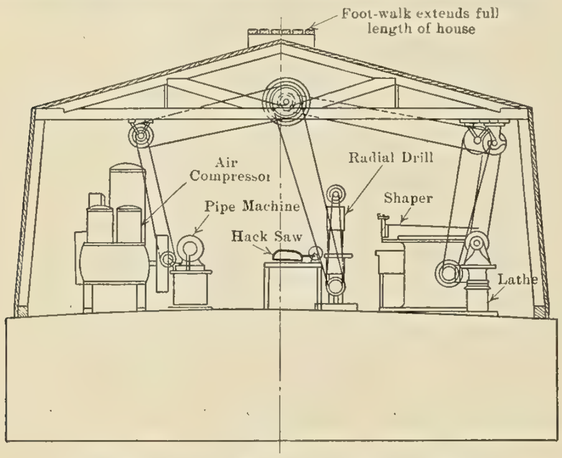


Fig. 1.—Section at Forward End of Barge

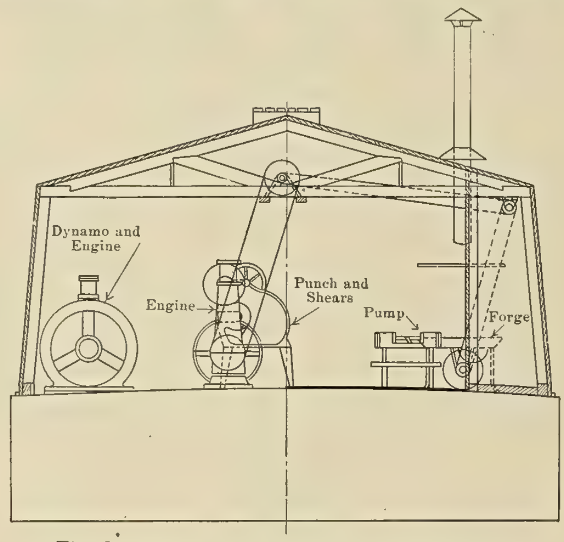
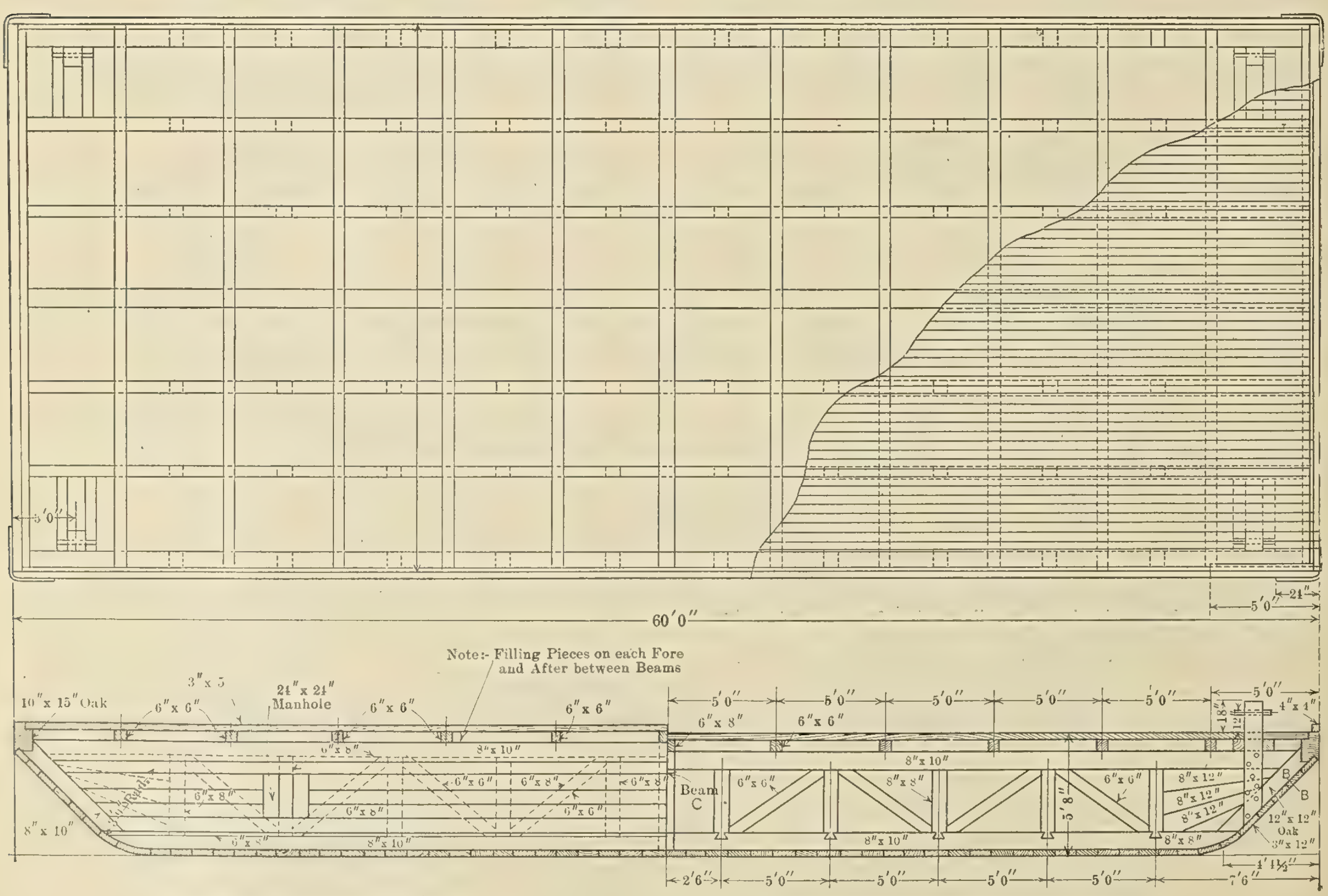


Fig. 2.—Section on Line *A-A*, Looking Forward



LONGITUDINAL SECTION ON FRAME No. 4

LONGITUDINAL SECTION ON FRAME No. 1

Fig. 3.—Construction Plans of Hull

therefore, a great deal of time was lost in transporting parts of machinery from the transports to the shops and then back to the ships again. It was impossible to rent a shop near the vessels, so it was decided to build a floating shop and equip it with the necessary tools to do the ordinary run of work as was at that time required.

A scow 66 feet long, 25 feet wide and 5 feet 8 inches deep, as shown in Fig. 3, was built and launched. A house was then erected on the scow, a cross-section of which is shown in Fig. 8. A coal bunker was built on the inboard side and a small ash bunker on the outboard side of the boiler. Next to the coal bunker was built a storeroom for bolts, nuts, small brass castings, hand tools, pipe fittings and numerous other small parts and equipment for the power tools.

The arrangement of machinery and shafting is clearly

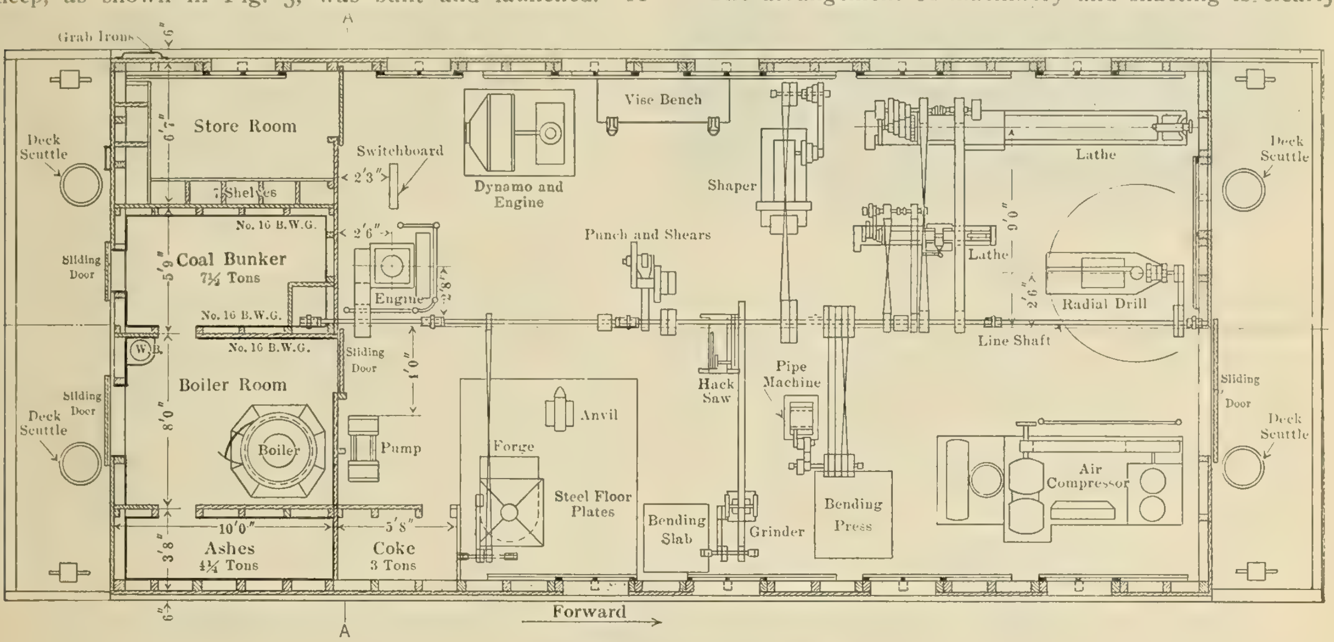


Fig. 4.—Plan of Machine Shop

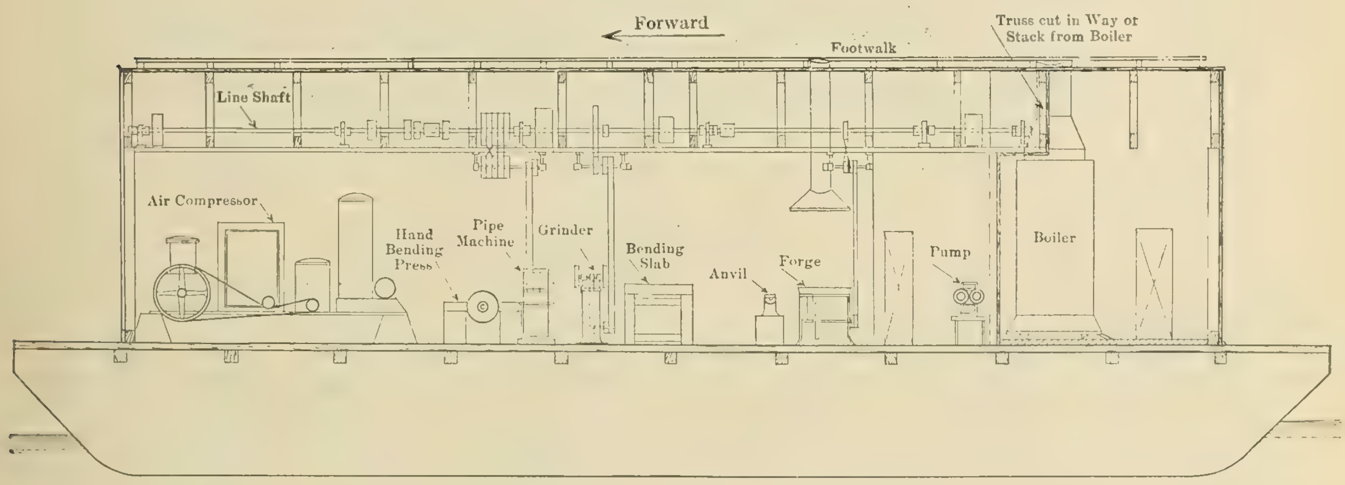


Fig. 5.—Elevation on Centerline, Looking to Starboard

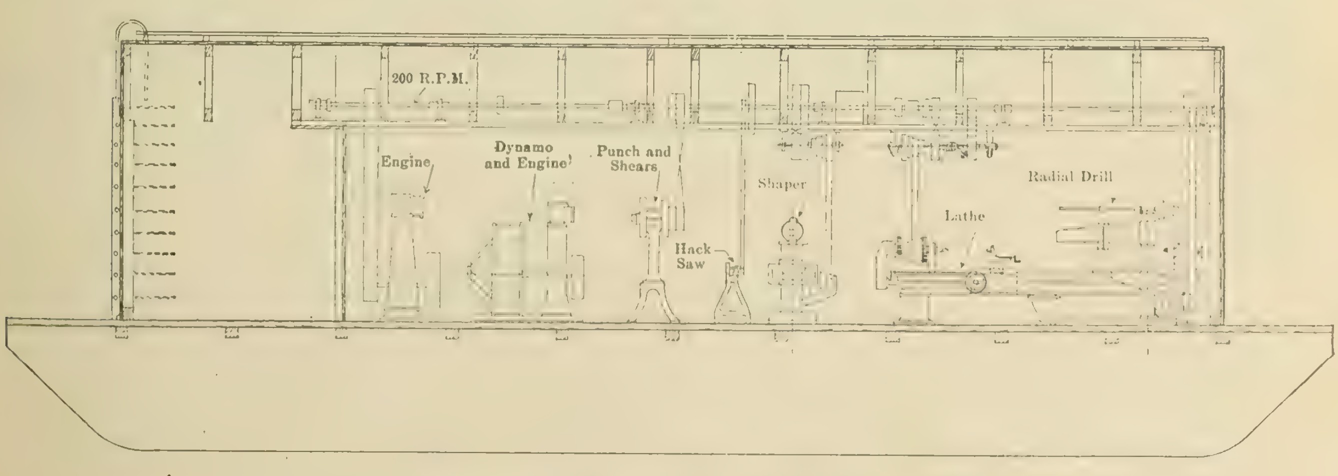


Fig. 6.—Elevation on Centerline, Looking to Port

Fig. 7.—Exterior View of Barge

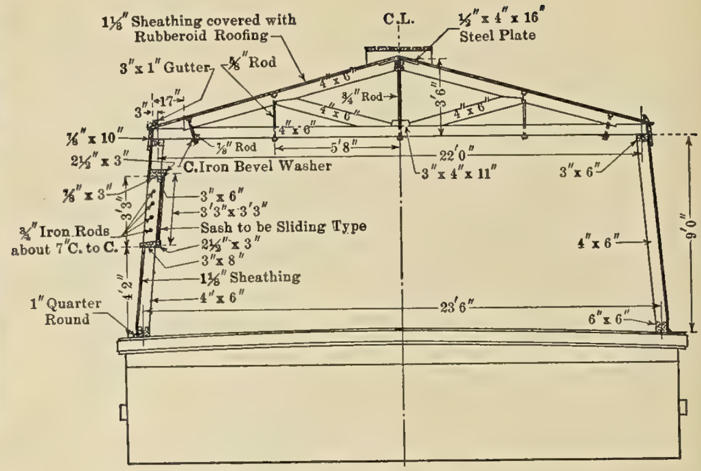


Fig. 8.—Section Showing Scantlings of Superstructure

shown in Fig. 4. The 8-inch by 8½-inch vertical engine is rated at 15 horsepower at 200 revolutions and is of sufficient power to operate all the tools at one time. The 8-kilowatt generator, run by an independent 5-inch by 5-inch vertical engine, supplies light for the shop and temporary lights to the ship undergoing repairs. The rated capacity of the air compressor for operating pneumatic tools is 140 cubic feet of free air and is run by a gasoline (petrol) engine mounted on the same base as the compressor.

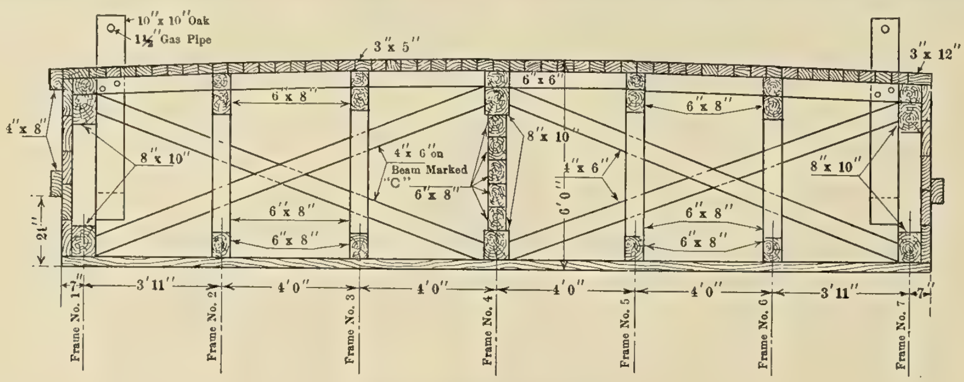


Fig. 9.—Midship Section

In addition to the above, the shop is also equipped with the following tools:

One 30-inch radial power drill, capacity 1¼-inch hole.

One crank shaper, 21-inch stroke with 16-inch vertical adjustment.

One heavy-duty screw-cutting engine lathe, 24-inch swing, 119-inch centers and 14-foot bed.

One 13-inch screw-cutting engine lathe, 45-inch centers.

One power hack saw, capacity 5 inches by 5 inches.

One power punch and shears capable of punching ½-inch hole in ⅜-inch plate or shearing 1½-inch by ¼-inch bar.

One power pipe-cutting and threading machine, capacity 1-inch to 4-inch pipe.

One power floor grinder with two emery wheels each 12-inch by 2-inch face.

One portable electric grinder with two 8-inch wheels.

One blacksmith forge with hearth 32 inches by 45 inches and fitted with a power blower.

One straightening plate 3 feet square.

One hand-bending press; size of table, 3 feet 6 inches by 4 feet.

One horizontal duplex pump, 6 inches by 4 inches by 6 inches, for feeding the boiler, pumping out bilges and fire purposes.

The shop is also equipped with the necessary work benches, vises, anvil, pipe racks, overhead trolleys and supplies that you would expect to find in a shop on shore fitted with the tools mentioned above.

When there is no need for the floating shop away from the shipyard it is then used as an auxiliary to the machine shop, thus becoming a valuable addition to the equipment of the shipyard.

Quick Delivery Gains Orders for American Yard

COMMENTING on the order placed by the Eagle Transport Company with an American shipyard for four tankers, the British paper *Shipbuilding and Shipping Record* says:

"In announcing the contract, the vice-president of the Standard Shipbuilding Corporation said that the average price asked by British shipbuilders was £40 to £45, and the American price $196 per ton deadweight. At the old rate of exchange this would mean that the Eagle Oil Company were paying £40 a ton, but owing to the present exchange they were paying £58, subject to variation according to the rate of exchange when payment will be made. It is apparent, therefore, that the price was not the deciding factor, but the earlier delivery which was promised by the American shipyard. The placing of this order recalls the orders placed by the Federal Line in 1913 for a firm of French shipbuilders, in which transaction also the question of delivery was the deciding factor. British yards are exceptionally busy at present and adequate supplies of steel are becoming increasingly difficult to obtain within reasonable time. This applies especially to steel plates."

The Commonwealth Dry Dock at Boston

A magnificent dry dock, the largest in the world and one of the finest pieces of engineering in the whole country, is the latest adjunct to the modern shipping facilities of the port of Boston. Although much work still remains to be completed in connection with this project, including the building and equipping of shops, storehouses and other accessories as an essential part of the plant for repairing vessels, nevertheless the docking of the United States battleship Virginia on December 22 marked the official opening of the new dock and signified to the shipping world that Commonwealth dry dock is ready for business.

COMMONWEALTH dry dock, constructed by the state of Massachusetts at a cost of more than \$3,000,000 (£630,000), was one of the several big features conceived and planned by the old Directors of the Port of Boston and carried to completion by the Commission on Waterways and Public Lands, when the former was abolished and its functions absorbed by the commission under the able chairmanship of Hon. John N. Cole, the gigantic task being supervised from start to finish by State Engineer Frank W. Hodgdon, with Assistant Engineer John N. Ferguson in charge of construction.

It was expected that the dry dock would be completed some time ago, but, like many other large undertakings, work was greatly retarded by the world war, with the result that for some four years this great work of concrete and granite has gradually been growing and shaping itself into its intended form, until it now stands complete.

Although planned and constructed by the state, the world war did more than delay the work on the big structure—it attracted the attention of naval authorities to the government's need of such a dry dock, particularly for docking a damaged battleship. It was not long before the national government was negotiating for it, with the result that the dry dock, with a considerable section of land adjacent thereto, was disposed of to the government for \$4,100,000 (£840,000), with the understanding that it was to be used for both naval and commercial purposes.

No better place in Boston harbor—and, for that matter, in any harbor—could be secured for such a structure, for, in addition to being in close proximity to the city proper, it is within a stone's throw of the main ship channel. Furthermore, its entire length rests upon a slate ledge—

Fig. 1.—Commonwealth Dry Dock. U. S. S. *Virginia* Berthed in Inner Section of the Dock

in fact, a large section of it is actually dug into the ledge. With its floor and dock walls resting upon this solid foundation, the walls are of mass concrete, lined with granite block. Its overall length is 1,200 feet, while the measurement between the copings of the side walls is 149 feet. The width at the entrance section is 133 feet at the coping, with sides sloped on one to eight batter, which gives a width at the elevation of the top sill of 120 feet. There is a depth of 35 feet at mean low water and 45 feet at mean high water at the entrance sill.

Owing to the great length of the new dry dock and the knowledge that it would be called upon to serve craft other than the largest now afloat and to do this economically, the dry dock was designed with an intermediate sill, as a part of the dock structure, the dimensions being similar to the entrance section.

which is made watertight, but with three hatchways, one being the large machinery hatchway, which provides an opening from the upper deck to the bottom of the caisson and the other two are small inspection hatchways. On this deck are located the 60-horsepower motors for the pumps, the operating platform, the electric switchboard and the float gage, which indicates the depth of water ballast, as well as the inclinometers, which indicate the trim of the caisson. A 200-foot, flexible, armored cable connects the caisson with a specially designed outlet box on the dock wall, which carries a 440-volt current to it from the pump house which operates the motors, and like provision is made for supplying electric lights.

There are two 10-inch pipes on either side of the caisson for supplying water ballast, and, though they discharge free to the interior of the caisson, each is controlled by

Fig. 2.—Commonwealth Dry Dock Under Construction, Showing Method of Placing Granite Facing on Interior Walls

With the caisson in position at this sill the dock is divided so that the length of the inner section is 668 feet from the inner end to the intermediate sill, while the other section is 520 feet long. Through this arrangement it is therefore possible to dock one ship of 1,140 feet, or, with the caisson in place at the intermediate sill, two ships, one of 635 feet in the inner section and one of 490 feet in the outer section.

This caisson, which is of the hydrometer type, is practically a ship in itself, and, when performing its function, occupies a position where it rests against a granite sill, extending along the bottom and sides of the dock. It is 138 feet 6 inches long and 27 feet wide, with a maximum height of 53 feet and a minimum draft of 28 feet 5 inches. Concrete ballast fills the bottom of the caisson, above which is the chamber for water ballast, which is admitted according to the varying conditions of draft.

Over the ballast tanks is the operating or main deck,

two gate valves, one of which is of the quick-closing type. For discharging the water ballast, two 20-inch volute centrifugal pumps of the vertical shaft type are provided and discharge at either side of the caisson. Each is provided with a five-port foot valve on suction, a motor gate valve at the pump discharge, and a flap valve at the end of the discharge pipe just outside the shell of the caisson. Its operation is simple. When a vessel is to be docked the dry dock is filled to the same level as the water outside, the caisson is relieved of sufficient water ballast by its own pumps until it floats at a suitable draft. It is then moved from the dock entrance by lines attached to electric capstans on the dock wall. The ship is then floated into the dock, the caisson drawn into position, and sufficient water ballast allowed to enter, until, with its weight, the caisson rests in position on the sill. The dock is then pumped out and the vessel is in position to be inspected.

Although the apparatus for filling and draining the dry

Fig. 3.—Interior View of Main Deck of Caisson, Showing Gate Stands in Foreground, Switchboard at the Left, Motors Amidships, with the Main Hatch Directly Beyond

dock is extensive, it is of the most modern type, and therefore the least complicated. There is one conduit 14 feet wide and 15 feet high, of arch section, which extends from the outer end of the dock to a point in front of the pump house, a distance of about 430 feet, and which is designed as the discharge conduit, receiving water from the main pumps. It acts as a filling conduit in the reverse operation by emptying through two sluice gates, each 6 feet by 8 feet, which are located in the conduit directly opposite the discharge from the main pumps. These gates discharge into filling chambers, which act also as diverting chambers, and connect with four conduits, leading out to the under side of the dock floor. One filling sluice gate fills into the two conduits which lead to the outer section of the dock and the other to the two conduits extending to the inner section beyond the intermediate sill.

During the process of pumping out the dock, the same four conduits become drainage conduits, and they extend to a common suction chamber. Each, however, is provided with a separate sluice gate 6 by 8 feet, so that it is possible to shut off any particular one or any number from the suction chamber. All are controlled by oil-operated hydraulic cylinders 19½ inches in diameter, in a special chamber outside of but connected by a passage to the pump well, the pressure used to operate them being 300 pounds per square inch.

Like the rest of the appurtenances, the pumping plant is thoroughly modern. It comprises three main pumping units, two small drainage units, one sump pump and two oil pressure pumps, all but the latter being of the vertical shaft type, each consisting of a volute centrifugal pump, direct-connected to an electric motor. The main dry dock pumps have a 54-inch suction and discharge, each being operated by a constant speed electric motor of 1,250 horsepower. The suction of each pump is connected directly, without a gate valve, to a separate concrete conduit extending to the common suction chamber. The discharge from the pump connects to a check valve of special design of the butterfly type, beyond which is located a 54-inch gate valve operated by a hydraulic cylinder, giving an increase from 54 inches to 60 inches diameter, the size of the large cast iron pipe which delivers the water to the main discharge tunnel. An oil dash pot serves to cushion the operation of the check valve, connected by piston rod and crank to the shaft of the flapper. The pump impeller is 71 inches in diameter and is of cast iron. The pump is so placed in the well that its centerline is at an elevation of 9.5 feet above the floor of the dry dock. The motor of the pump is located on the main floor of the pump house, 55.5 feet above the dock floor, or one foot higher than the coping of the dock and 46 feet above the pump. It is of the constant speed induction type, with a speed of 240 revolutions per minute. The total weight and thrust of the pump impeller, shaft and rotor of motor are sustained by a spring-supported thrust bearing, the rubbing surfaces of which are constantly in a bath of oil.

One hundred thousand gallons per minute is the guaranteed capacity of each main pump, and the combined average overall efficiency of the pump and motor is 56.5 percent. A slight excess in both of these figures is shown by official tests. Operating together, the three pumps are capable of unwatering the dry dock in from two and a half to three hours.

Of the same type as the main pumps are the two small drainage pump units, having 15-inch suction and discharge openings. They are principally for draining the dock floor and conduits underneath which lead to the common suction chamber. A 20-inch pipe controlled by a hand-operated

The contractor for the construction of the Commonwealth dry dock itself and the pump house was the Holbrook, Cabot and Rollins Corporation, Boston and New York. The Weiss Construction Company, Boston, Mass., built the pump house, while the Donnelly Iron Works, Inc., supplied the interior stairways and guide-gearing supports for pump shafts. The Worthington Pump and Machinery Corporation, New York, furnished the pumping plant, and the electrical apparatus was furnished through that company by the General Electric Company, Schenectady, N. Y. The Chapman Valve Company, Indian Orchard, Mass., through the pump contractor, furnished the gate valves of the plant. The sluice gates of the dry dock and caisson valves were manufactured by the Coffin Valve Company, Boston, Mass. The Bethlehem Shipbuilding Corporation, Bethlehem, Pa., built the caisson. The caisson pumps were furnished by the Worthington Pump and Machinery Corporation, as sub-contractors, and the electrical apparatus sublet to the General Electric Company. The Wellman-Seaver-Morgan Company, Cleveland, Ohio, furnished the electric capstans and the General Electric Company the electrical work, while the hand-power capstans were furnished by the Dake Engine Company, Grand Haven, Mich. The Whiting Foundry and Equipment Company, Harvey, Ill., furnished the traveling bridge crane, and power circuits for caisson and capstans were installed by Irving L. Matson.

gate valve runs from the bottom of this chamber to 15-inch branch pipes with a hand-operated gate valve on each pump suction. The discharge of each pump is connected through a 15-inch gate valve, operated by hydraulic oil pressure cylinders to the common 20-inch discharge pipe, which contains a four-port check valve and extends outside of the pump well in the masonry of the dock wall to the outer end of the dock and is wholly independent of the main discharge conduit. The 20-inch suction pipe mentioned above connects by means of a Y-branch and hand-operated gate valve to the bottom of the main discharge conduit, so that this may also be pumped out, after placing stop planks in grooves provided at the outboard end. There is also provided a 20-inch tee branch supplied with a gate valve and suction pipe for pumping out the pump well itself in case of emergency. The pumps are located 4.5 feet below the dock floor, and their motors are on the main floor of the pump house, 60 feet above. Each of these motors is rated at 150 horsepower, having a speed of 600 revolutions per minute, operating on 3-phase, 60-cycle, 440-volt current. The type of thrust bearing is the same as for the main pump motors. The guaranteed capacity of each drainage pump unit is 6,400 gallons per minute, and the combined average overall efficiency of the pump and motor is 52.0 percent. Official tests indicate an excess of each of these figures.

In addition to this equipment for operating the dock proper, a small 3-inch centrifugal pump is installed in the sump at the bottom of the pump well, 72 feet below the pump house floor, for removing the seepage into the pump well. The discharge from this pump connects into the discharge pipe of the 15-inch pumps. This pump is controlled by an automatic switch, which is operated by a float in the sump chamber.

Five electric capstans of the most modern type form a part of the dry dock's equipment, two being located on either side of the dry dock and one at the inner end, for use in berthing and unberthing vessels. The one located at the inner end of the dock is for hauling vessels in. The other four are located so that one pair serves the inner and one pair the outer sections of the dry dock, or, if need be, any or all can be operated at the same time. These capstans are operated by 250-volt direct current, which is taken from the pump house installation, the alternating current there being converted by a rotary converter and carried in a loop circuit completely around the dock. This circuit is provided with special junction boxes at manholes in the dock wall, so that connections may be made for direct-current service to the capacity of the converter.

In addition to the electric capstans, there are six hand capstans, three on each side of the dock, as well as 32 cast iron bollards. These are so spaced between the capstans that one is located on either side of the dock at about 60-foot intervals.

In the construction of the dry dock, consideration was given to the possibility of additional equipment in the future, and, with this in mind, the masonry of the dock wall, as well as that of the pump house, was liberally provided with ducts for electric cables, openings for water and air pipes, etc., so as to enable the introduction of additional electric and compressed air equipment for working on vessels in the dock.

Located about opposite the intermediate sill of the dock, and setting back from the dock wall some 50 feet, is the pump house, in which is housed all the main equipment for supplying power, etc., for the operation of the various pumps, capstans, etc., of the dry dock itself, and, like the dry dock, its foundations are embedded in the slate ledge. It is a brick structure with granite trimmings, well lighted from all four sides, with the main entrance facing the dry dock and midway in the building itself. Windows and entrance are of the arched type, reaching close to the eaves. The heavy equipment is on the main floor.

A switchboard located upon a balcony above the main pump-house floor controls the electrical equipment. The operation of the hydraulic cylinders on the sluice gates and the valves of the main and drainage pumps is controlled at another board adjacent, thus affording centralized control for all apparatus. The power for operating the pumping plant is derived from 3-phase, 60-cycle, 13,800-volt service supplied by the Edison Electric Illuminating Company. From this 13,800-volt bus are taken two circuits through separate high-tension oil switches, one of which passes to a bank of three single-phase transformers, each of 1,250 kilo-volt amperes capacity, stepping down the high-tension supply of 13,800 volts to 2,200 volts required by the main pump motors. The other circuit passes to another bank of three single-phase transformers, each of 150 kilo-volt amperes capacity, stepping down the 13,800-volt supply to 440 volts required by the other motors of the pumping equipment, the caisson pumps and other uses at the dock.

Included in the miscellaneous equipment is a storage battery charging set for operating high-tension switches and relays; two triple-action plunger pumps with an accumulator to maintain an oil pressure supply system for operating sluice gates and gate valves; a 220-kilowatt rotary converter for supplying the five electric capstans, with direct current at 250 volts. There is also a 20-ton, hand-operated traveling bridge crane in the pump house for handling pumps and motors.

A feature in the pump house is the three recording water level gages by which the operator may be constantly informed during any operation of the dock as to the tide elevation and the water level within the dock. These also are on the operating balcony, one for tide level and the other two for water level in the inner or outer sections of the dock.

With a depth of 35 feet at mean low and 45 feet at mean high water at the sill, the Commonwealth dry dock can safely care for the largest vessels afloat or likely to be built for a long time in the future, and also for the largest naval vessels, however badly they may be damaged.

Some conception of the size of the project involved in the building of this dock can be obtained from the fact that in excavating, approximately 344,000 cubic yards of earth and 83,000 cubic yards of rock were removed. Approximately 180,000 barrels of cement were used to make the 120,000 cubic yards of concrete of the dry dock. In addition, a channel 1,800 feet long, from the dry dock to the main ship channel, was dredged, during which process 628,000 cubic yards of material were removed. Approximately 400,000 cubic yards of filling were used for the back walls.

Crude Oil Burning Marine Engine

A crude oil-burning engine of the surface ignition, low-pressure type is now being manufactured by the Jacobson Engineering Company, Inc., New York City. Unlike the Diesel, Hvid, or Brons type engines, the two-cycle surface ignition design does not require the high-compression pressures of 450 to 600 pounds, nor the air injection pressure of nearly 1,000 pounds, but operates at little above the pressure of the automobile engine. Ignition is obtained by means of a surface which, on starting, is heated externally by a kerosene (paraffin) blow torch, but which maintains its own heat while the engine is running.

Financing the New Merchant Marine

Provisions of the Mortgage Bill—American Marine Insurance—Movement to Encourage Investment of Capital in Shipping—Attitude of the Bankers

BY WALDON FAWCETT

As Congress has progressed in the consideration of legislation for the establishment of an American merchant marine, it has become more and more apparent that one of the truly vital problems bound up with this issue is that of the financing of the new merchant marine. Financing, as the term is here used, has not reference, be it explained, merely to the financial arrangements for the transfer of the governmental fleet to private ownership. That in itself is, to be sure, an important responsibility, and, as our readers know, much discussion has been devoted to the terms to be accorded shipping interests that desire to take over on the partial payment plan the tonnage acquired by the United States Government during the war.

Overshadowing this temporary problem, if it be so denominated, is that larger aspect of financing which involves the enlistment of financial backing for the ownership and operation of ocean-going vessels. Here the necessity is not merely governmental co-operation (though that is necessary as a means to the end), but the securance of generous support from the banking interests of the entire country and the muster of the general investing public. This last, in particular, is a formidable undertaking. Shipping securities must compete with other forms of investment in a field that is assiduously cultivated from the very fact that the United States has lately been transformed into a creditor nation. Worse yet, the American people have ceased, in more than half a century of neglect, to think in terms of shipping investment. Behold, then, the necessity for arousing the great body of small investors to the opportunities of the merchant marine as a source of profit as well as a gratification of pride and patriotism.

Evidence of the widening realization in the legislative branch of the Government that the financial element is most important in the upbuilding of an American merchant marine has been found lately in the action of the chairman of the committee on commerce of the Senate in seeking to have incorporated as a section of the general merchant marine act the provisions of what was originally known as the Mortgage Bill. This measure is designed to remedy some of the inequalities and remove some of the complications that have heretofore resulted from the existence of liens on vessels, and the suggestion that it be made an integral part of the basic legislation evidences the feeling that the issue is intimately bound up with the fundamentals of a mercantile marine policy.

As though the obvious points of contact were not enough, it has been disclosed latterly at Washington that this self-same consideration of financing the American merchant marine is likewise part and parcel of the problem of providing all-American marine insurance for the fleet that is to be. Talking to this text, Fields S. Pendleton, shipbuilder, shipowner and ship operator of New York, recently addressing the members of the Senate committee on commerce, said:

"The foundation for a successful merchant marine is a sound, steady and strong policy of safety and security to the investor. It matters not how much money there is in Chicago, Minneapolis, Jacksonville or New Orleans, you cannot secure it unless you can show that the investment is safe, and that it will pay a reasonable return. The safety of the investment depends upon the protection afforded by the insurance; therefore, insurance is absolutely essential to the upbuilding of the American merchant marine that will protect the investment, if the ship is lost, so that the investor may have his money back even with the low rate of interest. Wherever the insurance is controlled the ship is practically controlled. The two principal factors are investors and insurance, and they go hand in hand. You cannot get the investor without the insurance. We must have more insurance facilities in this country."

That the attraction to the new American merchant marine of capital seeking investment has direct as well as indirect significance for the shipbuilding industry no less than for shipping interests was hinted in conversations at the Capitol by Homer L. Ferguson, president of the Newport News Ship Building and Dry Dock Company. Analyzing with frankness the situation that confronts his industry, President Ferguson said: "The prospects for shipbuilding in this country depend largely upon merchant shipping. The present shipyards—certainly the ones that were in existence before the war—were dependent upon two factors: one, the small amount of coastwise shipping that was built, and the other the naval shipbuilding. Since the war the Navy Department has equipped a large number of navy yards to do the major part of its own building, so that the future of the shipbuilding industry in this country depends upon the merchant shipbuilding."

Answering a question as to what is necessary to encourage the upbuilding of a permanent, adequate American merchant marine, Mr. Ferguson said: "The building of ships depends on their successful operation and profitable operation by the purchaser. That is more so in this country than abroad, although some shipbuilding companies have undertaken the building of ships which they themselves will operate, or through their agents, but in general it depends upon the purchaser finding a remunerative employment for that ship. Of course, no business that has not that as a background can exist any better than we existed before the war, from hand to mouth, and building every kind of thing.

"It is assumed by some that things are going to be so different, following the war, that we can both build and operate in open competition without any preferential assistance of any kind for our own shipping. The experience, however, of a hundred years before the war, and the assumption that most business men would make, I believe, would be that when things quiet down again we are going to be in about the same condition of competition that we were before. In shipbuilding, such as we have done during the war—building a large number of ships of the same type for war purposes—we have departed a good deal from ordinary shipbuilding, where a ship is designed and built for special service, and it seems to me perfectly plain that unless the United States is prepared to adopt some kind of policy that will give preferential

treatment to its own ships, built in the United States owned, operated and manned by Americans, we cannot look to anything very much better than we had before. In general, we have tried to operate a perfectly free merchant marine in a protected country, and it has not worked and it will not work."

Addressing himself to the essentiality of support from the investing public, the head of the Newport News yard said: "We must have shipping so that the investing public, the investors as a whole, are interested in the purchase of shipping shares. In that respect it is quite similar to the railroad situation. The question of credits, the question of raising money, the question of operating ships, depends upon the sureness with which the investor believes his money is invested and will yield him a fair return."

With rare discernment and commendable breadth of vision, Mr. Ferguson has sensed the influence that is likely to be exerted upon the creation of a place for shipping in the American investment market by the policy that the Government may pursue in disposing of its war-begotten fleet. He discounts the theory that the sale of the ships (if made with due regard for replacement value) will prove a menace to American shipbuilders, and holds instead that if the ships are busy and profitable to private owners more ships will be wanted by those same owners and by others who will follow them into this newly revealed investment field. Mr. Ferguson holds that if the Government gives assurance of a stable policy of preferential treatment for American ships it can be reasonably expected that private capital in the United States will absorb from 8,000,000 to 10,000,000 tons of American shipping within a year or two.

Summing up his conclusions with respect to the all-important financial side of the merchant marine proposition, Mr. Ferguson said: "There are men who are willing to take a gamble, but I do not believe that you have yet an atmosphere for the creation of a market for ships so that investors will be willing to put their money into it to make a real merchant marine. I do not think that at this time there are enough of us in the business to make a merchant marine, and what we want is a widely scattered ownership and a stability of value that will tend to create that ownership." Incidentally, Mr. Ferguson gave it as his opinion that we hear too much these days regarding the plain cargo ship, whereas, to use his words, "the real need in a merchant marine is, in my judgment, a ship that carries people as well as cargo." He holds that the first-class passenger ship built in a well-equipped shipyard constitutes a tremendous factor in developing trade with any country and that the passenger ship is especially important just now for the cultivation by the United States of the trade of South America.

The importance of the creation of a considerable body of qualified American ship operators as a prerequisite of any flow of American capital into the channels of merchant marine investment has been emphasized at Washington of late by Wallace Downey, the shipbuilder. Commenting on the encouraging outlook in this respect, Mr. Downey said: "The knowledge of shipping is gradually growing in this country. A lot of young men are developing rapidly. In 1913 or 1914 you could count the shipping operators on the finegrs of your hand, almost. But out of all of the upheaval there are men who have come along—bright, brilliant young men, and they are learning—and if the Government stands by and gives honest, intelligent co-operation, this proposition can be worked out." Mr. Downey holds that the profitable conditions that would make of vessel property a form of investment to attract American capital are essentially "a matter of intelligent management."

As the subject has unfolded in the discussions in committee session at Washington, there has been increasing recognition of the part that the bankers of the nation must play, if the investment capital of the nation is to be, to any adequate extent, mobilized for the support of the American merchant marine and the development of the shipyards that will stand behind an American mercantile fleet. Shipbuilder Downey, discussing this angle of the issue, remarked: "If there were some form of procedure possible in this nation so that one could go into a trust company or bank and secure a loan on a ship like we do on a house, it would give this whole thing a constructive motion at once. The great shipping of the British Empire is founded and fostered by the fact that the shipowner with 25 to 50 percent of the money that the ship is going to cost, goes to the shipbuilder, and the shipbuilder goes to the banker, and then the owner and the shipbuilder and the banker all get together by carrying 50 percent or 60 percent of the mortgage and they put the ships over one after another. The ship mortgage is a sound investment, and it is a lever by which they have built up their tremendous shipping trade."

It is by reason of intimations such as the above that the framers of national legislation are devoting so much attention to what are known as the "mortgage features" of the pending legislation. Vigorous representations on the same subject have been made to the commerce committee of the Senate by Robert Strange, representing the United States Steamship Operators' Association. Commenting on the need for better arrangements with respect to this angle of ship financing, Mr. Strange said: "In the vicinity of New York, at least, a ship mortgage at the present time is considered a joke. If a shipowner comes to borrow money, they either make him transfer title to the vessel as security or they make him put up collateral. Anything that will improve this situation and improve the financial service will be very beneficial, particularly to the operators." He went on to say that some betterment of conditions is precedent to the ownership and operation of large numbers of merchant vessels by private interests, no matter whether the vessels be acquired from the Government or obtained under contract from American shipbuilders. It is recognized by shipowners that it may be necessary to embody in the legislation to be enacted certain safeguards to prevent a shipowner from placing a fictitious mortgage on a vessel merely to defeat subsequent lienors, but it has been urged that care be taken that these provisions be not objectionable to bankers, and especially that there be incorporated no provisions that would affect the salability—that is, interfere with the assignment of a mortgage.

There is a feeling that the cause of enlisting permanent investment backing for an American merchant marine in private hands is likely to be furthered in consequence of the calling into consultation as advisers on a Shipping Board policy of seventeen nationally prominent men of affairs. Of the "business doctors" who, beginning in the middle of April, are regularly to advise on the method, price and terms for the sale of the Government ships to private owners only, Charles Dawes, of the Central Trust Company of Chicago, ranks primarily as a banker. However, many of the other members of the new advisory body have served on bank directorates, and almost without exception the selected captains of commerce have had experience in "selling" bankers on their respective propositions, as well as selling the consuming public, so that it is expected that this newly recruited group will be in a

position to weigh all the elements of a permanent merchant marine policy with due regard for the enlistment of lasting and dependable financial support, widely distributed.

On this same financial equation which has received attention at the hands of so many of the shipbuilders and ship operators who have recently journeyed to Washington to give the Government the benefit of their suggestion, P. A. S. Franklin, president of the International Mercantile Marine, has sought to emphasize the importance of using the present Government-owned fleet as a means to cultivate popular interest in shipping investments, and especially to concentrate such interest as may be aroused upon the financing of regular lines of steamers. On this latter score, President Franklin, in discourse with members of the commerce committee of the Senate said: "The tramp business is a profitable business and it is a desirable business, but the commerce of the country, the great percentage of the valuable trade, such as the trade in manufactured articles, requires a regular service to ports."

Asked by Senator Ransdell what must be done to bring the American people back into the shipping business and to persuade them to think in terms of shipping investment, Mr. Franklin said: "You have to offer attractions. You have to offer inducements to capital to get into this business. What the United States wants today is a policy to create—a constructive policy to establish your shipping firms and your shipping houses who are anxious to get into the trades of the world on as sound a basis as you can and a basis as attractive as possible to capital, so that they can get capital to finance themselves. We should try to do something that is constructive and which is going to last."

The attitude of bankers with respect to shipping investments has been indicated in the conferences at Washington by William F. Collins, secretary of the committee on commerce and marine of the American Bankers' Association. This committee stands committed to a policy of co-operation with Governmental agencies in studying, formulating and recommending a safe and consistent plan of ship financing. However, to date it has given no concrete assurances as to what the banking interests of the country would do to encourage new shipping enterprises. However, if encouragement from banking quarters has been in terms of generalities, there have not been wholly lacking concrete suggestions of ways and means for placing shipping securities in the hands of the public. For example, there is the suggestion of Fields S. Pendleton that in the case of future construction American shipbuilders accept part payment for tonnage in bonds and that they in turn distribute these bonds to the interests from which they purchase material, with the alternative of placing the bonds with banking connections or in any quarter where they would be held as investments.

Stoke-Hold Efficiency—III

BY A. POHLMAN

ASSUMING that the reader has digested the previous articles on this subject and is therefore familiar with the use of the flue-gas analyzer we will proceed.

Let us assume a Scotch boiler installation operating under forced draft. How is the analyzer going to help us? First see that a U-tube, or, better still, a direct-reading draft gage, is attached to the blower outlet. Remember that the whole problem is one of getting the right mixture. There is a certain relation between the thickness of the fuel bed, if you are burning coal, and your blower speed, or the amount of opening of the valves supplying the burners and the blower speed, if you are using liquid fuel. We could compute theoretically the number of cubic feet of air necessary to burn a given quantity of fuel, but we are going to have our analyzer do this for us.

Having a draft gage and an analyzer, we drill a hole large enough to pass a piece of one-quarter inch pipe through into the smokebox door, about a foot above the top row of tubes and in the center, and insert a piece of pipe long enough so that one end is about midway between the tube sheet and the door, and the other end a

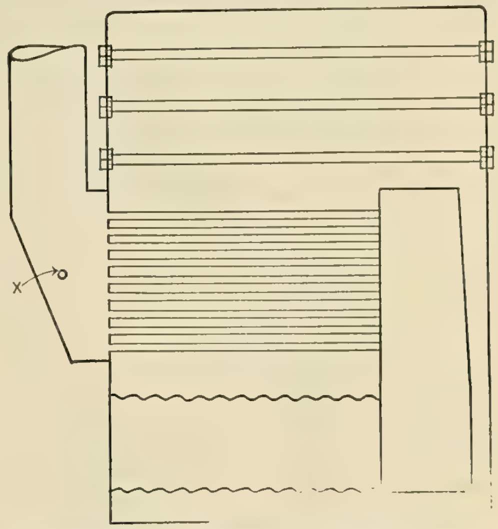


Fig. 1.—Scotch Marine Boiler. Cross Shows Where Gas Samples and Temperature Should Be Taken

few inches outside the door (see sketch). To this latter end attach the rubber tube which leads to the analyzer.

We are now ready to do some useful work. First level the fire (we are assuming a coal burner) and read the draft gage. Assume that it reads an inch and a half, and that our fire is ten inches thick. Drawing a sample of gas, suppose we find our CO_2 reading as seven percent. (Before proceeding, let me suggest twelve percent as the mark to aim at. I use twelve percent because experience

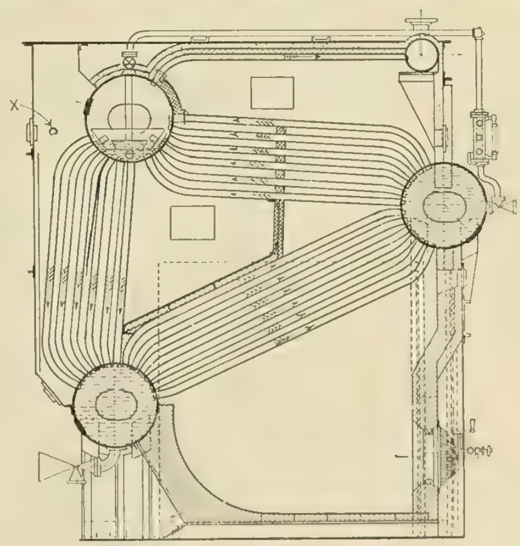


Fig. 2.—Watertube Boiler. Cross Shows Where Gas Samples and Temperature Should Be Taken

has shown that this may be considered a very good working average.)

Seven percent of CO_2 is low. We want 12. Why was it low? Low CO_2, while not always, usually is an indication of excess air, so we assume this to be the cause. By reducing the blower pressure to, say, one-half or 75 inches, and thickening the fuel bed to twelve inches, we

find the CO_2 up to eleven percent. We now reduce the blower pressure to one-half inch, but leave the fire as it was, as this may be considered heavy enough. Again we analyze a sample and find our looked-for twelve percent. We now know that with that particular coal carried in a twelve-inch, fire-bed, one-half inch blower pressure is required. If the thickness of fire is increased, the draft or blower pressure must be increased. If the coal is changed, get busy again with the analyzer and establish the proper draft to fuel thickness as described above.

It is suggested that an hour or two be devoted to this work the first day out. Don't stop at a few samples. Take several dozen at different drafts and fuel thicknesses and make up a schedule, or, better still, a chart showing the various drafts required for various fires. Hang this up in the engine room. As a dependable guide, put a tapbolt in the fire-door liner at the point you decide is the proper height of fire.

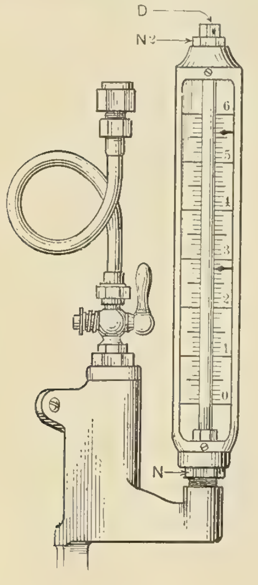


Fig. 3.—Hays Direct Reading Gage. This Type of Gage Displaces the V Gage and Can Be Read at a Glance. It May Be Used for Pressure or Vacuum Within Its Scale

Fig. 2 shows a watertube boiler and the cross indicates the point at which to collect the sample. Remember that in any installation the place to take a sample is at the point where the gases leave the heating surface of the boiler. Before arriving at this point the gas has not completed its work and given up its entire heat. After this point is passed the gases do not interest us. In the case of the watertube installation, should the percentages be uniformly low and no variation appear when the fire-doors are opened and closed, it will indicate short circuiting of gases, due, probably to broken down baffling. A pyrometer inserted in the different passes through the dusting slides will usually indicate which baffle is damaged. There is a decided drop in temperature from one pass to the other, if the baffling is in good order.

On oil-burners, this type of installation is handled the same as regards the gas analysis, as on the coal burner, with the exception that instead of playing with the fire-bed we use the valves that supply the burners. It will usually be found that a very light touch of the handwheel will make a decided difference. It is suggested that a marker plate of light sheet metal be fastened to the stuffing-box nut of the valve and the handwheel marked. The graduations on the plate should be pitched at, say, an eighth of an inch. The pump pressure should remain constant. It might be added that when burning oil it will be found that a light brown haze comes from the stack when the highest percentages of CO_2 prevail. Should no means of analyzing flue-gas be found aboard a ship burning oil, try to secure this stack effect. A perfectly clean stack usually indicates a fuel waster.

Where natural draft is used with an oil-burner the links in the damper-chain should be numbered, or, if a quadrant and lever are used, the quadrant should be marked.

Water tenders should be impressed with the fact that a blower running like mad and sending up a shower of sparks does not mean steam but furnace repairs and blower breakdowns. If a large volume of air is supplied, the fuel must be supplied to absorb it. In coal burning, there is a limit to the number of pounds per square foot of grate surface that may be consumed.

Where it is possible to secure them, direct reading draft gages should be used. At the best a U-gage is unhandy to read and particularly when it comes to dark corners a water tender is apt to be human and guess. Another eyesight-saving scheme is to put a few drops of Japan white in the water in the leveling bottle of your analyzer. This remains in suspension and has no effect on the gases, while the analyzer scale will stand out clearly and can be read with greater ease.

(To be continued.)

The Largest Shipyard in the World*

New Boilers Installed

Two additional Babcock and Wilcox boilers, each of 266½ horsepower, were first installed at the south end of the old power house with high settings; that is, 10 feet from the floor to the under side of the tubes, thus giving increased combustion space, eliminating smoke and increasing the economy. Jones underfeed stokers were also installed under these boilers to secure better combustion of fuel and a reduction in labor for carrying increased load that had developed. This arrangement proved satisfactory in every way and was adopted as a standard for future installations.

In the new extension which was added to the power house, six Keeler watertube boilers of 400 horsepower each were installed. These were equipped with high settings, Jones underfeed stokers, overhead Berquist coal bunkers with Link Belt coal crushers and conveyors, so that the fuel can be dumped directly from the cars into track hoppers and crushed, conveyed and stored in overhead bins, whence it feeds by gravity to the hoppers on the top of the stokers at the boiler fronts. This arrangement eliminates all labor as regards hand firing, the amount of labor saved being two firemen and two coal passers per watch of eight hours.

At the rear of the boilers two new Cameron two-stage turbine-driven centrifugal feed pumps were installed along with a Cochran feed water heater which automatically measures the entire amount of feed. There was also installed two Permutit water filters of very large capacity for filtering the entire feed water required for the power house. This was found necessary, as the feed water is taken from the Delaware river and at certain times of the year is filled with sediment, which causes a great deal of tube trouble in the boilers. The filters have entirely eliminated this trouble and reduced the repair bill at least 75 percent. These boilers are also equipped with Bayer's soot blowers for cleaning the soot from the outside of the tubes.

A triple combination draft gage is installed on each boiler to show the draft over the fire at the stack and in the blast pits. General Electric steam flow meters are installed on each boiler for indicating the flow of steam

* Concluded from April issue.

from each unit and are used to equalize the load between each boiler. Coal counters are also installed on each stoker, which have been carefully calibrated, from which the coal readings may be taken at any period desired.

Automatic CO_2 recorders with gas collectors are also connected for maintaining high combustion conditions. Besides this, pyrometers for watching the temperatures of the stack gases, and in fact everything that would lend itself to high operating economy, was installed and is used, with the result that the plant is now operated with an average evaporation of about 10½ pounds of water per pound of coal from and at 212 degrees Fahrenheit.

The new boilers are connected to a radial brick stack of the same dimensions as the stack already mentioned by means of a steel flue which is swung very high in the boiler room. This is lined with 2 inches of special vitrobestos material, which eliminates the waste of a considerable amount of heat which would otherwise be radiated from the ordinary brick flue.

It is intended, when improvements which are now being made are completed, to eliminate the present coal trestle and bankers in front of the fire room and also to utilize the present coal conveyor as an ash conveyor, openings having been placed in the floor in front of each boiler, so that when the fires are cleaned the ash and clinker can be emptied right into these openings and conveyed to overhead ash bunkers, whence they can be emptied directly into railroad cars or trucks as desired.

Engine Room Extension

Two 2,500 kilowatt, high tension, alternating current, 2,300 volt General Electric turbines, one 600 kilowatt, high tension, alternating current, 2,300 volt General Electric turbine and one 1,250 Allis-Chalmers turbine generator have been installed along with one turbine-driven exciter of 25 kilowatts capacity and three motor-driven exciters, two of which are of 50 kilowatts capacity and the other of 9 kilowatts capacity. There is also one 500-kilowatt rotary converter installed in the engine room, along with a modern up-to-date switchboard.

At the south end of the engine room two Ingersoll-Rand air pumps are installed along with the batteries, controlling gear and recording tapes for the Gamewell fire alarm system, which has been installed throughout the yard.

Under the engine room there is a basement in which, on the west side, is located a high tension wire vault. There is also a main with air intake for ventilating the high tension generators. These units discharge the hot air in the basement. On the east side, there is installed a 52-inch main exhaust pipe with outlets and special exhaust valves to each unit. These exhaust valves, which are 48 inches in diameter, are so arranged that they can be operated by hand, which, of course, is a very slow process, and also by electric power with a push button. This exhaust pipe leads outside to a Bayer barometric condenser, which is guaranteed to maintain a vacuum of 28 inches with the circulating water at 70 degrees Fahrenheit and 100,000 pounds of steam being supplied per hour. The injection for this condenser is supplied from two Cameron motor-driven centrifugal pumps of 8,000 gallons capacity each, the motors being high tension, 2,300 volts, located in the new pump station known as the *T* and *U* pumping station. The distance from this pump station to the condenser is a little over 1,400 feet, the size of the supply pipe being 24 inches in diameter.

In conjunction with this condensing outfit a duplicate unit is also installed to take care of the reciprocating end of the power house, having a duplicate set of air pumps.

It was also necessary to provide and construct a new pumping station at the head of the wet slip some 600 feet away. Two pumps were installed, one of 4,300 gallons per minute capacity and the other of 6,000 gallons per minute capacity.

It was found necessary to increase the general water service and fire systems, one system being used for both purposes. Accordingly, the new pump house, known as *T* and *U* pumping station, was built on the river front at the head of one of the wet basins. This building is of fireproof construction, being built of reinforced concrete, brick and steel. The roof is of a slab concrete construction.

Fire and Water Service

Provisions were made for three high-pressure fire and general water service pumps and three low-pressure water service pumps, two of these being installed at the present time to serve condenser No. 2 of the power house. Each low-pressure unit is of 8,000 gallons per minute capacity under 25 pounds pressure with single-stage Cameron centrifugal pumps driven with high-tension, direct-connected, 2,300-volt motors. Two high-pressure pumps, also of the Cameron make, were also installed in this station, each of 1,500 gallons per minute capacity against 110 pounds pressure. They are also driven by direct-connected, high-tension, 2,300-volt motors. Inside along the west side of this station is a 20-inch-diameter main suction header connected to three separate suctions which run outside and into the river. Each suction is equipped with sliding strainers so that they can be cleaned readily. The header and suctions are piped up in such a manner that any one, two or three can be used at the same time.

These high-pressure pumps discharge into a common underground general water service and fire system, which is also looped in and connected with a duplicate pumping station built on Newton Creek in the South Yard. The new part (south end of yard) has been laid out by means of underground valves and street boxes so that parts of this system can be shut off at any time in case of break, repairs or additional connections. The main is 12 inches in diameter, being of class "D" Bell and Spigot cast iron pipe.

There are also four fireboat connections on as many piers in the North Yard. Each connection has three outlets, so that three 3½-inch hose lines can be connected from the fireboat. This furnishes four sources of water supply for fire protection, namely, one from the three original Underwriters' fire pumps, one from the *T* and *U* pumping station, one from the South Yard pumping station, and in case of these failing there still remain the three fireboat connections.

Since 1918, due to the extension of the plant, about 30,000 lineal feet of fire and water service pipe have been laid underground and above ground in the North Yard.

Two Ingersoll-Rand air compressors were installed, each of 2,700 cubic feet per minute capacity for 100 pounds pressure. They were placed in what is known as *T* and *U* substation.

Torpedo Boat Destroyer Plant

This plant is of temporary construction, the buildings being mainly frame and, in some cases, frame stucco. The plant consists of ten ways (four open and six covered), a plate and angle shop, administration building (with miscellaneous offices and storerooms for various departments, also toilet and washrooms for the workmen), a special paint department, a large substation and galvanizing plant.

In the substation there are installed two Chicago

Pneumatic air-compressors, each having a capacity of 3,600 cubic feet of air per minute at 110 pounds pressure; two triplex hydraulic pumps made by the Aldrich Pump Company, each having a capacity of 25 gallons per minute at 1,500 pounds per square inch pressure; one accumulator, also made by the Aldrich Pump Company, to control these pumps; two fuel oil pumps and two Wilbraham-Green blowers, each having a capacity of 1,360 feet per minute at 2 pounds per square inch pressure. These blowers were installed for the plate and angle, rivet heating and other furnaces required in the plate and angle shop. There were also installed four vertical coal-fired boilers, 54 inches in diameter by 11 feet high, carrying 125 pounds pressure, for supplying the necessary steam for testing, heating galvanizing, etc. All the above machinery is driven by direct connected, high-tension, 2,300-volt motors.

Electrical Equipment

The electric equipment in this station consists of two 350-kilowatt rotary converters with static transformers for lighting and an extensive switchboard.

Galvanizing Plant

The building containing the galvanizing plant is very large and well ventilated. In this there are three special tanks arranged in tandem constructed of heavy spruce planking. The galvanizing pot is placed some distance from these tanks. The tanks and galvanizing pot have a capacity for handling plates 7 feet wide by 26 feet long.

An unusual feature about this plant is that no oven or steam coils are required for drying plates. The process is first to dip the plates in a sulphuric acid tank, in which is a large agitator, consisting of a wooden plunger about 12 inches wide running the entire length of the tank. The mechanism is driven by an electric motor through worm and worm gearing to a shaft with rocker arms that link to this agitating plunger, the rocker arms being fitted with balanced weights. The plunger, working up and down, causes the acid to splash at a high velocity on the metal and, it is claimed, removes all scale and rust in a very short time. The plates are then emersed in hot, fresh water, and from there are dipped into a third tank containing a hot muriatic acid solution. Upon being taken out of this tank and brought out in the air, the plates dry off very rapidly. As no ovens are necessary to dry the plates, they are sent out to the other end of the shop, finished.

An overhead monorail system served with Shepard electric hoists of 2 tons capacity each, with floor control, handles all the material through this shop.

A system of special syphons and drainage was found necessary to take care of the emptying, washing, etc., of these acid tanks. Indicating and recording pyrometers are also installed on the galvanizing kettle, so that the metal will not be overheated or burned.

Plate and Angle Shop

The plate and angle shop of the destroyer yard being a low, one-story building, would not permit the installation of overhead traveling cranes. The equipment is as follows:

One double-ended angle furnace, capable of heating angles and channels up to 45 feet long.

One small angle furnace, taking work up to 6 feet long.

One plate-heating furnace, capable of taking plates 6 feet wide and 30 feet long.

Three double-ended rivet-heating furnaces, all being equipped with low-pressure oil burners.

One hydraulic joggling press, 150-ton capacity.

One 50-ton horizontal hydraulic cold press.

One 100-ton hydraulic lightening hole punch.

Two 80-ton hydraulic shears.

One Sellers plate planers for 30-foot plate.

One Southwark plate planer for 27-foot plate.

Two Long and Allstatter double-ended plate punches, 40-inch gap.

Two Long and Allstatter plate punches, 48-inch gap.

Four radial drills with 60-inch radius.

Three Post double countersinking machines.

One guillotine sheer, plate 48 inches.

Four 30-inch gap punches.

One notching machine.

Two 24-inch gap punches.

One pair of plate-bending rolls, 10 feet.

All these machines were equipped with the necessary tables, skids, etc., in addition to eight laying-out tables. In the angle shop are the following tools:

Eight No. 3 horizontal punches.

One single notching machine.

One double No. 2 angle sheer and turntable.

One straight No. 2 double-angle shear.

One angle planer.

There are also six double-jointed jib cranes, each of one ton capacity on the assembling floor.

This shop is also served with nineteen jib cranes of two tons capacity, having a jib 20 feet long and each equipped with an electric hoist, floor operated. These hoists were supplied by Sprague, Shepard and the Link-Belt Company.

Plate and Angle Shop No. 2

Plate and Angle Shop No. 2, 269 feet wide by 792 feet 6 inches long, consists of three bays, the west bay being the angle shop, the center bay the plate shop, and the east bay the plate storage space. The mold loft, 650 feet long, is built over the plate shop. This building is of modern construction, being mainly steel finished in stucco and built of brick.

In the plate and angle furnaces coal has been resorted to as a means of heating in place of oil. The reasons for using coal as fuel are, first, scarcity of the grade of oil fuel used in this yard (28 to 32 Baume oil); second, that 60 percent to 70 percent of the fires in the shipyards during the war was due to oil fuel, and, third, the coal-fired furnace, such as is used here, has shown an economy of one-half the cost of oil.

There are two angle furnaces; one will take angles and channels 60 feet long inside, and the other 30 feet inside of doors. The 60-foot angle furnace is equipped with eight small Dutch ovens; the 30-foot angle furnace with four Dutch ovens and four special Jones underfeed stokers. The plate furnace, 7 feet 6 inches wide inside, will take a plate 30 feet long between ends. This is equipped with seven Dutch ovens and seven special Jones underfeed stokers, four on one side and three on the other. This plate furnace is also connected to a stack with large plate-controlling dampers. The two angle furnaces are connected to one stack with separate controlling dampers.

These furnaces are designed to deflect the flame directly over the metal in the furnace, and the flame, passing down under the hearth, produces very easily the same heat both on the underside and the top, viz., 2,200 degrees F., and, if necessary, higher temperatures can be maintained. Angles 8 inches by 6 inches by ⅝ inch by 50 feet long are heated in the long-angle furnace in six minutes with a very soft bending heat. Plates 6 feet by 25 feet by ⅞

inch thick are heated in the plate furnace in 22 minutes to a very soft bending heat; in fact, it is not possible for one crew on the slabs to work these furnaces to the maximum capacity. They prove very economical in fuel and very efficient in heating. When working these furnaces full capacity, a quantity of three pounds of metal to a pound of coal is shown. The long furnace averages on big material 14 tons for 24 hours.

Addition to the Forge Shop

An addition to the forge shop was also found necessary for handling heavy forges. A United Engineering Company's combination steam hydraulic forging press was installed having a capacity of 1,200 tons pressure and taking in ingots 38 inches square. Two special heating furnaces were designed to serve this press, one furnace having a single charging door to take in 38-inch square ingots, the charging door being 6 feet wide by 40 inches high, the other furnace having two charging doors of smaller dimensions. The furnaces are 10 feet wide inside.

These furnaces are heated by means of two Jones underfeed stokers of standard design, set in a special combustion chamber at the end of the furnace; the flame passing over a bridge wall enters the heating chamber, which has a roof arched in both directions. This arch, in a lengthwise direction of the furnace, falls to within about 18 inches to 2 feet of the hearth at the rear end, thus causing the flame to encircle the forge, which rests on the sill of the charging door and supporting wall in the center. This keeps the forging from the hearth of the furnace to a distance of 12 inches, allowing the flame free circulation under the bottom as well as over the top of the ingot. The combustible gases in the flame leave the furnace at the hearth at the rear end of the furnace and enter a flue which is built below the floor line and connects to a stack which has a separate lining and is guaranteed for a temperature of 2,000 degrees. A water-cooled damper is installed in each of these flues to control the draft.

A heat of 2,400 degrees F. is easily maintained in these furnaces. Sand-cast ingots 38 inches square and 10 feet long can be heated and soaked and ready to work in from 18 to 19 hours' time. After working, these heats can again be brought up ready to work in from 3½ to 4 hours' time.

A 35-ton Pawling and Harnischfeger overhead crane serves this press and furnace. This crane has swung on the hook a separate turning gear with flat-linked chain 10 inches wide, made by the Brown Hoisting Machinery Company for handling and turning the forgings. The crane and turning gear are entirely controlled on the floor of the forge shop adjacent to the press operator.

Additional extensions were also made on the forge shop at the east end by increasing the drop forge and small hammer departments. An addition to the original plate shop No. 1 was also found necessary, consisting of a new oil furnace of the same size and capacity as the one already described in plate and angle shop No. 3, with two Long and Allstatter double punches with 60-inch gap. These punches are equipped with Lysholm plate tables, and the necessary 5-ton jib cranes with hoists, etc.

In addition to the above, extensions were made to the general storehouse, plate storage sheds, etc.

A new power house and substation were built in the South Yard, the fire room being equipped with four Keeler watertube boilers, each of nominal rating of 400 horsepower with a steam pressure of 175 pounds. These boilers are equipped with underfeed stokers of the Jones standard type, fuel being hand-fired from the bunker into the stoker hopper. In addition to these four boilers, there are two large outside-packed plunger duplex feed pumps made by the Epping-Carpenter Company of Pittsburgh, a large Cochrane metering feed water heater, one Permutit filter, two spare injectors, Bayer soot blowers and all the necessary draft gages, gas analysis apparatus, flow meters, etc., for working these boilers efficiently. The boilers are connected to a radial brick stack 150 feet high by means of an overhead steel flue with vitrobestos lining 2 inches thick.

An hydraulic accumulator, 17 inches diameter, 10 feet stroke, is also located in the corner of the fireroom. On the other side of the division wall between the engine room and the fireroom are located two large triplex motor-driven hydraulic pumps of the Aldrich make, which have a capacity of 150 gallons per minute, 1,500 pounds pressure per square inch, automatic unloading attachment. There are also installed in this room two tandem compound duplex drinking water pumps, made by the Epping-Carpenter Company, also two small duplex fuel oil pumps, two Ingersoll-Rand motor-driven air compressors, each having a capacity of 3,600 cubic feet per minute, 110-pound pressure (provisions being made for a third unit, if necessary); two rotary converters, 500-kilowatt capacity each, are now installed, with a provision made for the third one, if found necessary.

There are eight 4½-inch artesian wells with a large receiving reservoir. These wells, although pumped automatically, can, however, be used as direct suction wells in case of air pressure failure. A complete underground system of fire and general water service lines, drinking water line, steam, compressed air and fuel oil lines is installed. This yard has two separate fireboat connections. The plate and angle shop is equipped with furnaces of the same types, size and design as those already described for plate and angle shop No. 2 in the North Yard.

The machine shop is heated in the same manner as the machine shop in the North Yard, by means of hot blast air recirculated over steam coils by means of forced draft fans driven by steam engines. The balance of the plant, including the offices, is heated by direct radiation when necessary.

All electric power required for the South Yard is supplied from the main power station in the North Yard, boilers being necessary to operate the forge shop to supply steam heat for testing purposes, etc.

For handling the material outside, the North Yard is equipped with eleven locomotive cranes and two locomotives, in addition to several small electric locomotives operated by storage battery. The South Yard is equipped with one locomotive and four locomotive cranes with several small electric locomotives operated by storage battery.

North Yard Extensions

A separate substation was built to serve plate and angle shop No. 2. This contains two hydraulic pumps of 75 gallons per minute capacity each, 1,500 pounds pressure, electric driven; also one accumulator 15 inches diameter by 10-foot stroke, all made by the Aldrich Pump Company, Allentown, Pa. There are also two rotary converters, 500 kilowatts each, with statics for lighting and one switchboard.

There has also been provided a very large brick building, on the second floor of which is located kitchens, bakeries, etc., and cafeteria complete to feed between 2,000 and 3,000 men. On the first floor of this building is located the refrigerating plant, with meat boxes, etc., coils, fans, engines, etc., for heating and ventilating.

The Largest Shipyard in Australia

BY JOHN O'TOOLE

Although Australia is still more or less a newcomer in the shipbuilding industry, construction in her yards has, within the last few years, practically made the Commonwealth independent of other countries in supplying the ships necessary to carry on her trade. The problems of obtaining materials and machine equipment for developing the existing shipyard facilities remained unsolved during the war, but extensions since then have been rapid. The development of the largest shipyard in Australia is typical of the expansion throughout the country. As late as 1913, *Walsh Island, the site of the Government Dockyard, was merely a mud flat at the confluence of the northern and southern arms of the Hunter River, discharging into Port Hunter, upon whose shores the important coal distributing center of Newcastle is located. Since that time more than* \$2,425,000 (£500,000) *have been expended in building up the island.*

SOME years ago, in order to improve the depth of the harbor on which Newcastle, N. S. W., is located, extensive dredging operations were undertaken, and it was found necessary to dispose of the silt on a mud flat at the mouth of the Hunter River. Thus the foundations of an island were laid, which was later selected as the site of a repair plant for harbor dredges and other public works, when the Commonwealth Government took over the State Dockyard at Cockatoo Island, Sydney, for use as a naval dockyard.

It was necessary to develop this embryo island very extensively before it could be utilized commercially, and to this end sand pumps were set to work building up the land from adjacent sand banks. A double advantage resulted from this work, for the harbor channels were deepened at the same time that Walsh Island came into existence. In its final form the island covers an area of 600 acres, 100 acres of which are at present used by commercial enterprises. Prior to shipbuilding, the shops erected on the island were engaged in constructing a number of steel bridges for railroad lines that were being developed throughout the Commonwealth.

Before the Government decided to engage in building steel ships for trade purposes, a large bucket dredge with a capacity of 12,500 tons per hour, two steam harbor barges each capable of carrying 1,500 tons of silt and four steam trawlers were completed.

Facilities of Yard

The shipyard equipment consists of three large building ways, each 360 feet in length and 60 feet wide, solidly constructed on concrete foundations: one smaller building slip and two patent slips for docking vessels up to 600 tons.

The machinery is modern in every detail and sufficient to meet the requirements of any ship built in the yard. The overhead gear consists of two hammer-head cranes 67 feet high, with a radial capacity of 101 feet and a lifting capacity up to 4 tons. Several long-jib cranes are also installed for handling lighter materials.

The plate shop is a steel building 197 feet in length and 123 feet wide, well lighted and ventilated. The machines are placed in parallel rows along the length of the shop,

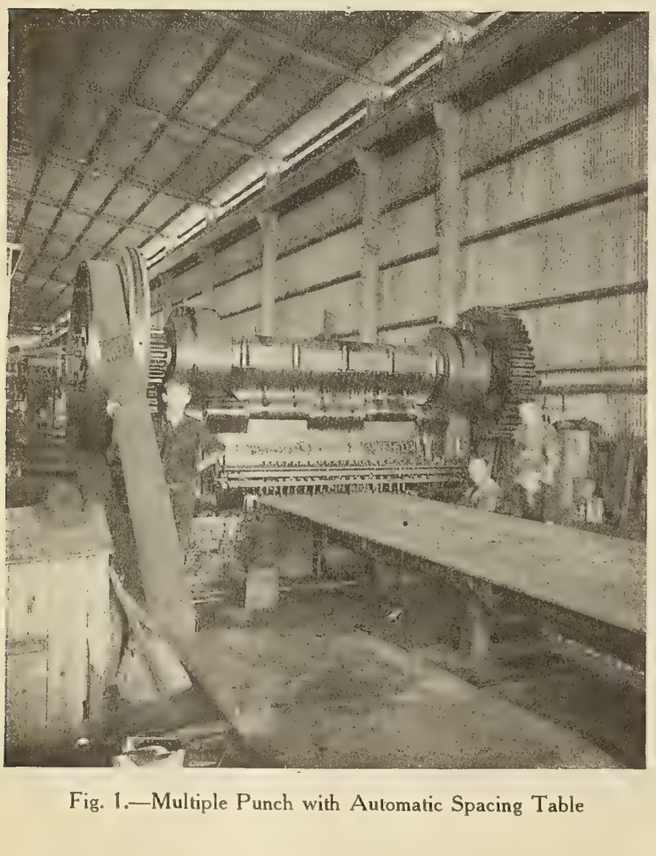


Fig. 1.—Multiple Punch with Automatic Spacing Table

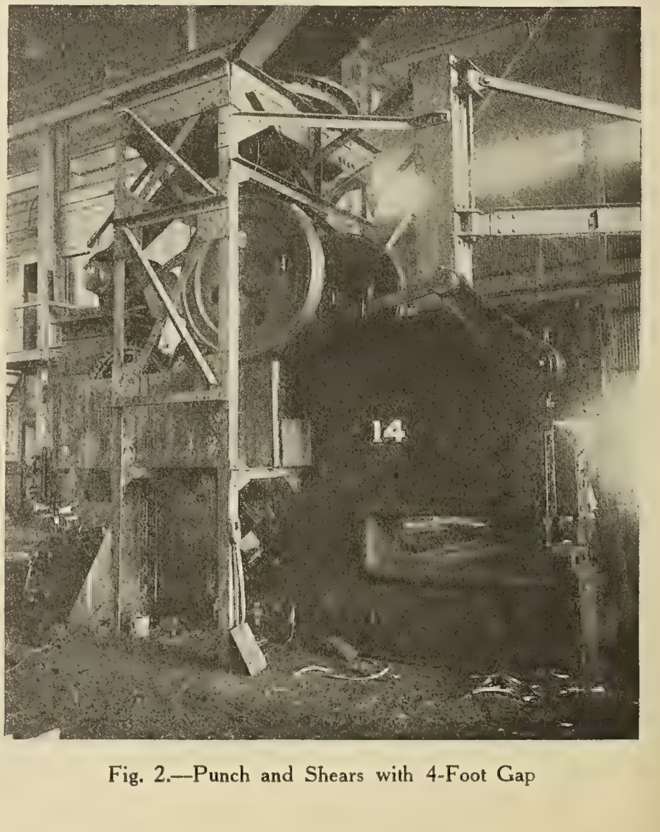


Fig. 2.—Punch and Shears with 4-Foot Gap

Fig. 3.—Center Bay of Boiler Shop

and include 12 punching and shearing machines, large plate planers, countersinking machines, 12 high-speed radial drills, two large sets of rollers, a mangle and pneumatic and hydraulic presses. A large multiple punch, as shown in Fig. 1, is one of the most important units in this shop. This machine can handle plates up to 26 feet by 6.5 feet, and has an automatic spacing table.

The largest punch and shears is shown in Fig. 2. This machine, having a gap of 4 feet, can punch 1¼-inch holes in 0.75-inch plate. All machine equipment in this shop is driven by individual motors. The shop is served by three overhead electric traveling cranes.

Details of Boiler and Machine Shops

The boiler shop and machine shop are both housed in a steel structure 265 feet in length and 265 feet in width. Fig. 3 shows a portion of the center bay of the boiler shop, with stacks of headers and tubes of Babcock & Wilcox boilers ready to be assembled for installation in Commonwealth steamers. Fig. 4 shows the casings constructed for these boilers assembled outside the shop prior to placing them in the vessels.

The equipment of the boiler shop includes one large hydraulic riveter, having a depth of 13 feet and capable of handling the heaviest type of work; one large hydraulic squeezer, capable of taking plates up to 13 feet deep, and one large hydraulic press for flanging boilers, etc. An up-to-date vertical boiler shell, double-headed drill press, for position drilling of boiler work, is also an important part of the equipment of the shop. In one corner of the shop a large drawing floor for laying out work is provided.

The machine shop is completely equipped with modern machine tools. Fig. 5 shows a view of the bay containing the large lathes, etc. Special equipment includes an extension-bed, faced, chuck lathe, having a length of 20 feet between centers, a gap of 9 feet, with a face plate having a diameter of 14 feet.

Fig. 6 shows the central portion of the machine shop where erection work is performed. The two sets of engines shown are the propelling machinery for Commonwealth steamers. These engines are triple expansion,

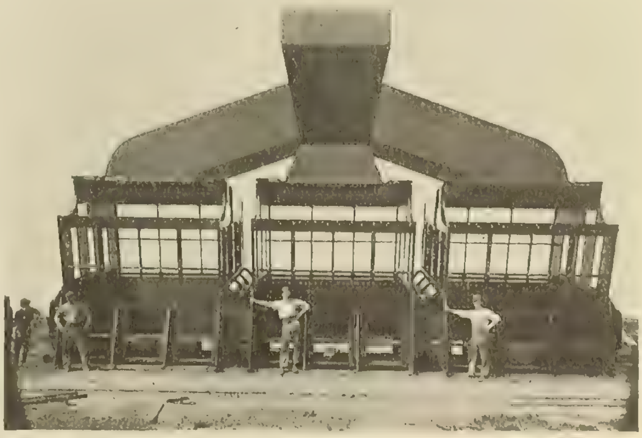


Fig. 4.—Boiler Casings Assembled

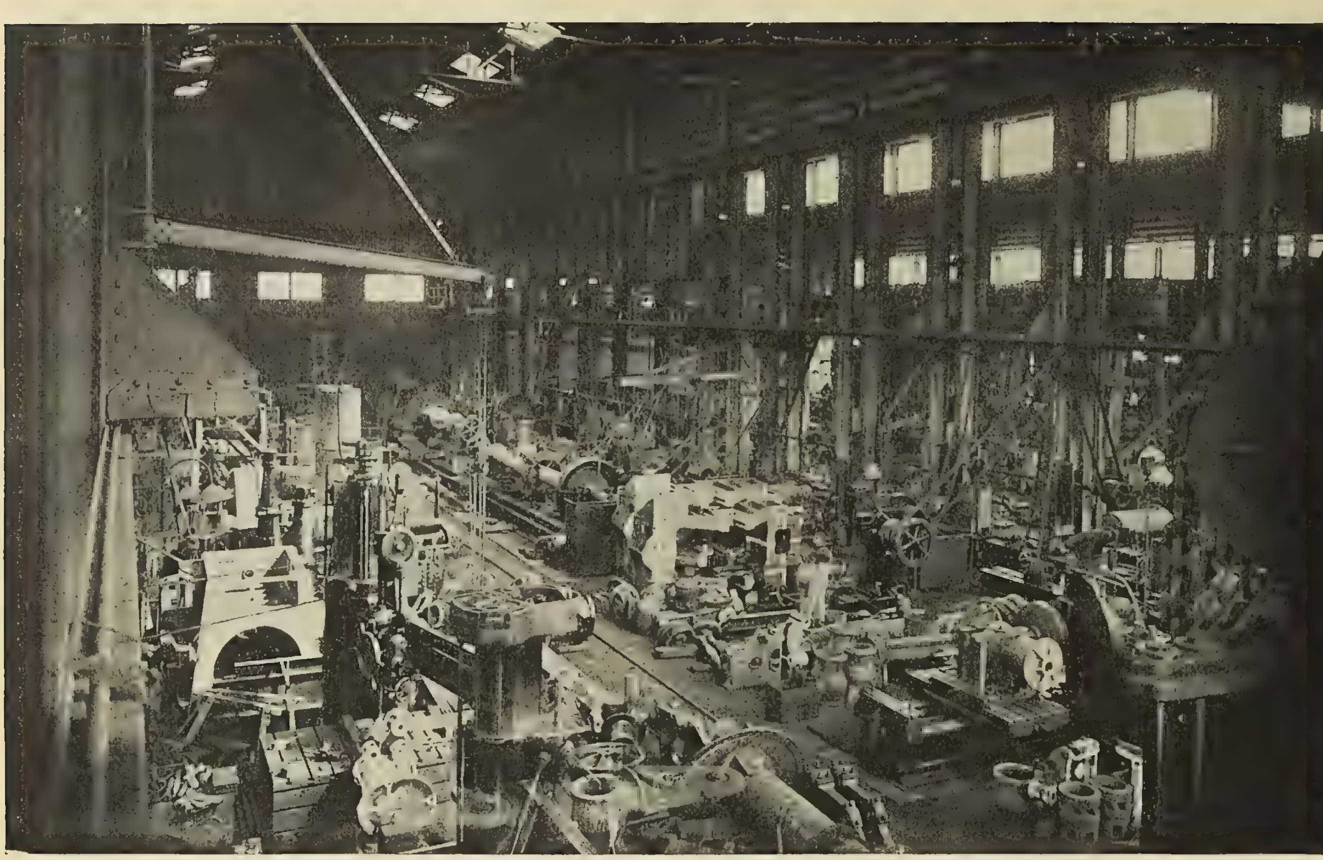


Fig. 5.—Center Bay of Machine Shop

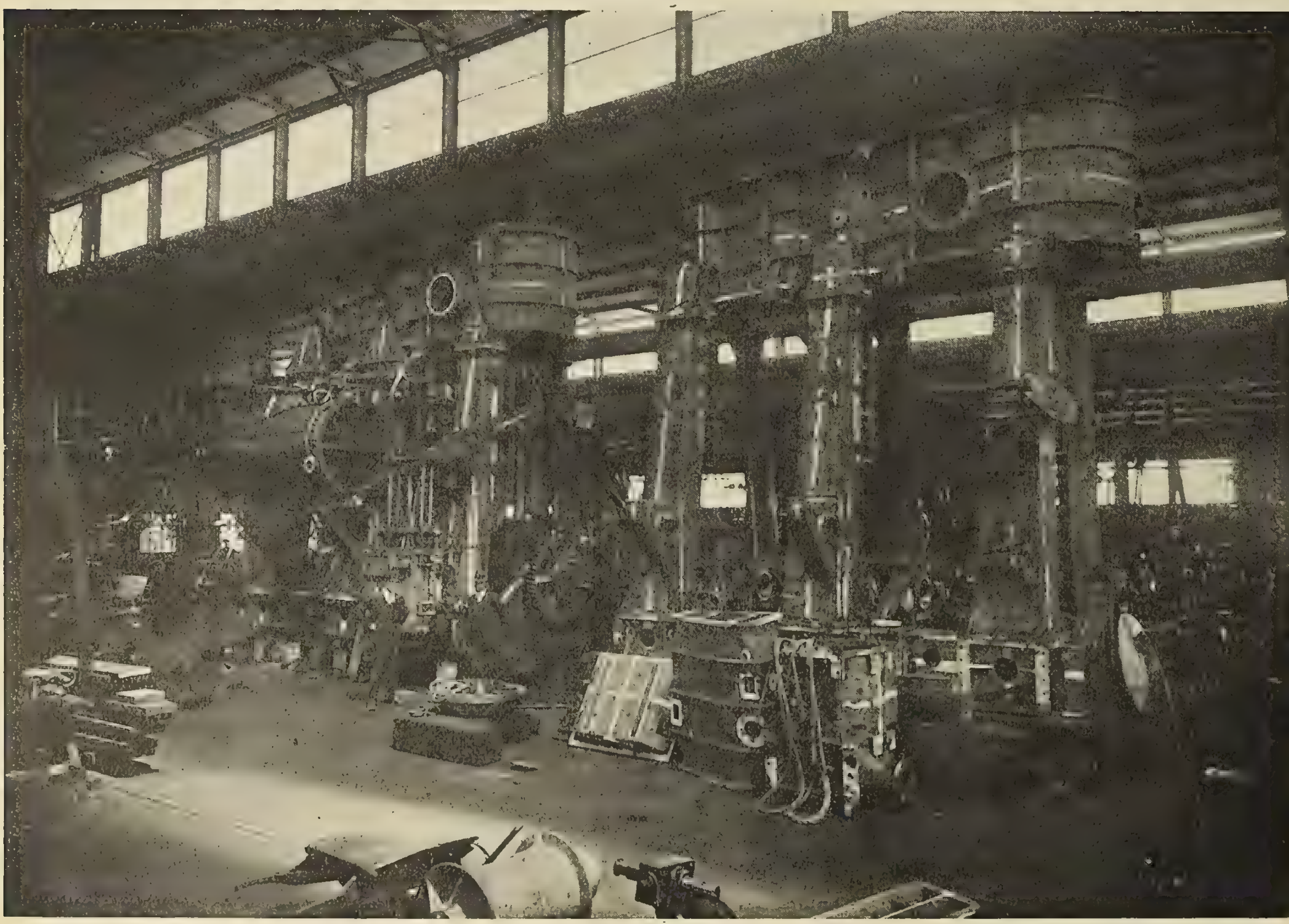


Fig. 6.—Assembling Floor of Machine Shop

Fig. 7.—General View of Iron Foundry

developing 2,300 indicated horsepower, with cylinder diameters of 25 inches, 41 inches, 68 inches and 45 inches stroke.

The foundry is a large steel building 650 feet long by 150 feet wide. It is equipped with three furnaces and under and over electric traveling cranes.

A general view of the iron foundry is given in Fig. 7, while Fig. 8 shows the large pipe casting platform, an important part of the foundry work being the construction of cast iron pipes for the State water supply department as well as for private firms.

Fig. 9 shows that portion of the shop allotted to brass foundry work.

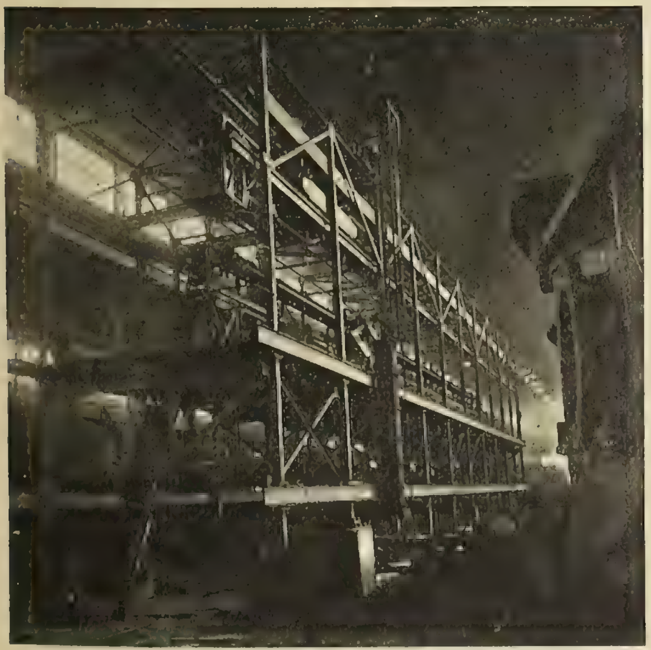


Fig. 8.—Pipe Casting Platform

FORGE PLANT FOR ENGINE WORK

The forging shop is well equipped and has a large steam hammer capable of a blow of 3 tons. All the heavy forging for crank shafts, etc., for the Commonwealth steamers was successfully carried out in the shop.

The blacksmith shop is a steel building 170 feet long and 90 feet wide, well lighted and ventilated, and is generally considered to be the best shop of its kind in Australia. It is equipped with powerful steam hammers, power presses, etc.

The mold loft is a wooden structure, having a floor length of 172 feet with a width of 70 feet. At the end of this building woodworking machinery is installed for handling the batten templates turned out for the plate shop.

The frame shop is situated under the same roof as the

Fig. 9.—Brass Foundry

plate shop, and is equipped with a double-ended furnace capable of taking plates up to 33 feet by 8 feet, and a series of bending slabs at each end of the furnace with an area of 1,730 feet. A beveling machine is situated conveniently near to the furnace for beveling ship frames, etc. Portable hydraulic rams for bending frames are also provided.

Other shops in connection with the establishment consist of well-equipped plumber, coppersmith, galvanizing, pattern, joiner, paint, plate making and timber shops.

The works are operated by a board of control, of which the Minister of Works and Railways of Australia is the chairman. The other members of the board are the Director of Engineering and the Director of Shipbuilding, both members of Government boards, and the shipyard manager and engineering works manager of the yard itself.

Motorship Building in Europe

BY OUR SPECIAL LONDON CORRESPONDENT

An event that is awaited with considerable interest in the British motorship building world is the completion of the first of the 14,000-ton, internal-combustion engined craft for the Glen Line, of which four are now under construction. These ships will surpass any similar boats that have yet been built, as not only are they larger, but they are designed for a speed of 14 knots, having a machinery installation of 6,400 indicated horsepower on twin screws. They are now being built at Glasgow by Harland and Wolff, who are also constructing the propelling and auxiliary machinery.

Although the engines are of the same nominal power as those installed in the *Glenapp* during the war, actually they develop considerably higher power, running at a lower speed and having larger cylinder dimensions. There are also many novelties in their construction, especially in the arrangement of the design of the framing for carrying the cylinders. Moreover, the whole of the auxiliary plant, which is on a large scale, is to be electrically operated, Diesel-driven generators being provided for installation in the engine room.

The marine oil engine having reached a stage when it permits the construction of 14,000-ton, 14-knot motor liners, the question immediately arises as to the employment of internal combustion motors on large and fast passenger boats. Speaking at the launch of the big Cunarder *Scythia* the other day, Sir James McKechnie, who is head of Vickers and is the designer of the well-known British submarine solid injection Diesel engines, stated that oil-fired boilers and geared turbines such as are installed in the *Scythia* are but the halfway house towards the oil-engine-driven passenger liner. Diesel engines of 4,000 horsepower are already being built, and it is anticipated that 6,000-horsepower, six-cylinder, two-cycle sets will be constructed within the course of the next year or two. By installing three of these engines in a passenger boat it would be possible to build a motorship of an equal size and power to many of the passenger liners now trading across the Atlantic.

The coal situation in England has become so acute that shipowners are in the greatest difficulties not only regarding their supplies but also because of the excessive running costs. The coal owners have lately agreed to reduce the price of bunker coals at British ports by $10 (40/0) per ton, but even now the nominal figure is $19 (75/-) per ton f.o.b. There are indications that the price will shortly be raised again to at least $25 (100/-), and it is therefore not surprising that the demand for motorships is increasing by leaps and bounds, and the only limit is the capacity for oil engine works to produce the necessary engines within a reasonable time.

Those motorships already on order are being pushed forward with the utmost rapidity, so much so that in some cases the trials of the engines in the works have been reduced to a minimum, a policy that may, perhaps, have unfortunate results. The new 10,800-ton motor tank ship for the Anglo-American Company is approaching completion at Vickers' yard and will be put into commission very shortly. She is the first post-bellum motorship constructed by the famous armament firm with engines of somewhat novel design, adopting the well-known Vickers solid injection system instead of using compressed air for the purpose.

All the large British marine engineering firms now recognize that it is inevitable for them to take up marine oil engine construction, and those who have not already done so are casting about for licenses for the construction of Continental types. The latest addition to the number is the firm of Hawthorne Leslie and Company, who are now building Werkspoor Diesel engines, while it is understood that Yarrows, who have long delayed coming to a decision, have at last decided on the manufacture of the Polar Diesel engine, somewhat on the lines of that built in America by McIntosh and Seymour, although it is believed that the Clyde firm will concentrate more upon the two-cycle than the four-cycle type.

There is in Europe, and especially in Great Britain, a big demand for the small seagoing cargo boat and the larger type of coaster carrying up to about 3,000 tons. In this field the semi-Diesel engine is seriously entering into competition with the Diesel motor, and in order to meet the requirements, two of the best-known British oil engine builders, namely, Beardmore and Vickers-Petters, have developed hot-bulb engines in four cylinders up to 600 brake horsepower per engine. It is thus possible to engine twin-screw ships with 1,200 brake horsepower, which is sufficient power for a 3,000-ton vessel, and the claim that is made, as against the Diesel engine, is that the semi-Diesel machinery is much simpler, costs less, and can be operated by less skilled engineers. In addition, Bolinders at Stockholm are manufacturing 500-horsepower engines as a standard model and are also developing one of 1,000 horsepower, this latter engine being now in the experimental stage, and if it proves successful it may have an important influence upon small motorship design in the future.

It is interesting to note that in connection with the development of this type of motor the first large motor trawler to be launched in England is fitted with one of the 600-brake-horsepower, Beardmore, semi-Diesel models. Trawler owners are watching this experiment with the greatest interest, for they have hitherto withheld their support from the internal combustion engine for use in trawlers, mainly on the score of unreliability and unsuitability for low speed. Beardmores hope to show the fallacy of these two opinions, and if they do there is little doubt that a big development in the construction of motor trawling may be anticipated.

National Marine Week and Exposition an Overwhelming Success

WITH the sounding of "taps" at five bells (10:30 o'clock) on Saturday evening, April 17, the exercises of National Marine Week were ended, and the marine show at the Grand Central Palace, Lexington avenue and 46th street, the greatest exhibit of industries allied to the nation's maritime interests which has ever been held, came to a much-regretted end—regret that it could not have been continued for another week, or longer.

The celebration began at two bells (1 o'clock) on the preceding Monday, when Joshua W. Alexander, Secretary of Commerce, pulled the whistle cord of the Oriental Navigation Company's steamer *West Alsek* at Pier 86, North River, and started a chorus of answering whistles up and down the river. After that and some other scenes were captured for the films, the party, which included Secretary Alexander, Rear Admiral W. S. Benson, chairman of the Shipping Board; P. H. W. Ross, president of the National Marine League, 268 Pearl street, New York, under whose auspices the celebration was held; Murray Hulbert, Dock Commissioner of New York and Director of the Port; members of the House Committee on Merchant Marine and Fisheries, and many others, was escorted by a file of marines, boys from the Nautical Training School and the Morse Dry Dock and Repair Company's band to one of the large rooms on the pier, where luncheon was served.

After the luncheon, President Ross, in the absence of August Belmont, chairman of the executive committee of the League, who was kept away by illness, briefly explained the purposes of the League and the objects sought to be attained by the exposition. Captain Sampson, of the Oriental Navigation Company, welcomed the gathering as guests of the company and made them feel thoroughly at home, after which Commissioner Hulbert told what New York was doing and planned to do to keep the lead in the race for the commercial supremacy of the country, in the way of making the port what it should be, the greatest port in the world, the one whose facilities for prompt and cheap handling of cargoes and ships would be unequalled anywhere.

Rear Admiral Benson, in speaking of the policy of the Shipping Board, declared that constructive criticism from all who knew anything about and were interested in the problems confronting the American merchant marine and the Board would be welcomed. He said that he was willing to be "the goat," and in fact was willing to do or be anything which would advance the maritime interests of the United States; but as he had only been in office four weeks, he had hardly had time to get a firm grasp on all the details. As a general proposition, however, it could be taken for granted that the Shipping Board would do everything in its power to put the merchant marine on a firm business foundation.

He realized that the questions confronting the Shipping Board were of vital importance to the country, but felt sure that they would all be worked out satisfactorily, and that the National Marine League was doing a great and substantial work in the way of educating the people to the importance of keeping the American flag to the fore.

Secretary Alexander gave some interesting details of the results of the activity in American shipbuilding brought about by the demands of the great war, showing what an enormous task the country had accomplished, and the great responsibility which now rested on those who had the handling of the great fleet so quickly created. He took the statistics for 1919 and compared them with the figures for 1914, and emphasized the need for a thorough appreciation of the vital importance of the merchant marine to the welfare of the country, and the equal importance of having it owned, officered, manned, inspected, insured and absolutely controlled by Americans. He assured his hearers that so far as the Department of Commerce was concerned every effort it could put forth and all the influence it could bring to bear would be devoted to that end.

After the brief exercises at the pier the company was taken to the exposition, where, after a few words by President Ross, Secretary Alexander and Admiral Benson, the United States flag and the flag of the National Marine League were hoisted and saluted, the band played "Columbia, the Gem of the Ocean," and the exposition was formally declared open.

On Tuesday evening the ninth annual dinner of the League was held at the Hotel Commodore, about 800 guests being present. Admiral Benson was the chief speaker of the evening, followed by Henry R. Sutphen, vice-president of the Submarine Boat Corporation, and Captain Irving L. Evans, of the recruiting service of the Shipping Board. Major Belmont was still the victim of illness, but sent a cordial note expressing regret at his absence, hope for the success of the exposition, and faith in the future of the merchant marine.

Electric Drive and American Personnel

Admiral Benson in his remarks placed special stress on the need of American seamen for the merchant fleet and said he would like to see all alien sailors and officers on American vessels replaced by native mariners. He also advocated the development of the electric drive and the Diesel engine for motive power, and announced that this would be one of the things the Shipping Board would advocate and forward by every means in its power. Oil-burning ships, he said, were the ships of the future, the Board was establishing oil fuel stations all over the world, and American vessels would not be handicapped in that respect. He showed the necessity of the nation taking an "investing interest" in order to make the merchant marine a matter of national pride, and warned also against what he termed a continution of the anti-American propaganda so active during the war and now being used against the establishment of the merchant marine. With regard to the personnel of American vessels and the making of sailors and manning the fleets, he said, in part:

"A merchant marine to be successful must have the support of all Americans. The only way it will have the support is to make the opportunities for advancement in our merchant marine so great that American boys in large numbers will be attracted to again enter seafaring life as they did in the early history of our country. We must strive for the day when we can honestly say we have an all-American manned and owned merchant marine.

"We know how long it takes to build the average freight ship. We know how much that ship should earn to be profitable. What we are facing is the need of more of

the right kind of youths trained for the sea, who enter our service on a merchant ship at the bottom rung with the hope, ambition and power to ultimately own the ship.

"Every hamlet has been reached in an effort to get the boys from interior towns to see life from a shipping point of view. Boys of vision should see the life as it is on board ships to know what fine training for future material happiness lies in store for them in the service of our merchant ships. It is easy work to obtain men to man the ships, but it is another matter to get men who are ship-minded and who enter the ranks with the hope and ambition to succeed as a ship operator."

Mr. Sutphen described the progress and development of American shipbuilding, the construction processes of the fabricated ships and the possibilities of the future for the merchant marine and the men who build the ships.

Captain Evans described the operation of the Shipping Board's recruiting service and training schools, the methods employed in making sailors and future officers out of raw country lads, congratulated the Marine League on its work and declared that the country need have no fear as to the quality of the men who would keep the flag afloat.

Deep Sea "Chanties" Sung by "Snugs"

Before the dinner a group of "old salts" from the Sailors' Snug Harbor, Staten Island, entertained the guests with a number of the old-time deep-water "chanties," including the "Dreadnought," "Blow the Man Down," "Whiskey, My Johnny," "Rio Grande," "Leave Her, Boys, Leave Her," and others, which were vigorously applauded, and one of the Snug Harbor men, 90 years old, was on the speakers' platform after the dinner and was cited by President Ross, of the Marine League, in his introductory remarks as being, like those Americans who had passed on the flag and now rested in Flanders Field, one of those who had borne the flag of the American merchant marine and now passed it on to the hands of the younger generation. Motion pictures of some interesting and intricate repair work at the Robins yard of the Todd Shipyards Corporation and the cruise of the training ship *Newport* were shown.

While this was going on at the Commodore, the three floors of the Grand Central Palace, which had been given over to the exposition, were crowded with people, many of whom had come out of curiosity, but went away with a lot of new ideas regarding the merchant marine.

The success of the exposition was overwhelming, and the throngs in attendance were so great that at times the doors had to be closed, the crowds going beyond what the police and fire departments deemed the safety limit.

Credit to Marine League

Pride and satisfaction in full measure justly belong to the National Marine League, 268 Pearl street, New York, for the time and labor expended in preparing for the celebration.

From far-off Tacoma to the whole length of the Atlantic seaboard, shipbuilders and all branches of industry connected with marine matters, as well as the Navy Department, the Department of Commerce and other Governmental agencies, have shown what they can do and are doing toward making the American Merchant Marine what it should be. The interest shown by the crowds which have attended the exposition is evidence that their efforts have achieved the result hoped for, and that the people are beginning to think ships.

Motion Picture Programme

The motion picture programme was of absorbing interest and kept the projection room full of spectators. The complete programme follows:

MONDAY, APRIL 12

Illustrated lecture on the "Diamond Mechanical Soot Blowers," by the Diamond Power Specialty Company.

Moving picture display by the Morse Dry Dock and Repair Company.

Illustrated lecture on the "Operation of the Barge Canal," by William T. Donnelly.

TUESDAY, APRIL 13

Moving picture film, "Keeping the Flag at Sea," by the Baltimore Dry Docks and Shipbuilding Company.

Moving picture display by the Astoria Boat Works.

Moving pictures showing the "Operation and Use of Delco-Light," by the Delco-Light Company.

Moving picture display by the Todd Shipyards Corporation.

Illustrated lecture by the Argonaut Salvage Corporation on the "Method of Recovering Sunken Cargoes and Raising Sunken Vessels."

Illustrated lecture by the Wilson Welder and Metals Company.

Moving pictures showing the "Operation and Use of Delco-Light," by the Delco-Light Company.

Moving pictures and lecture demonstrating the "Manufacture of the Allison Stockless Anchor," by Allison & Company.

Illustrated lecture by Mrs. Jaime C. de Veyra on "General Conditions in the Philippines" for the Philippine Commercial Agency.

WEDNESDAY, APRIL 14

Moving picture display of the "Poole Turbine and Gear Manufactured by the Ford Motor Company," by the Poole Engineering Company.

Moving picture and lecture demonstrating the "Manufacture of the Allison Stockless Anchor," by Allison & Company.

Moving picture and illustrated lecture by The De Vilbiss Manufacturing Company.

Moving picture display by the Columbian Rope Company.

Illustrated lecture by the Lake Engineering Company describing the advantages of the commercial submarine boat and apparatus for submarine exploration and investigation, and in recovering the natural products of the seas; also on their ability to materially shorten certain trade routes.

Moving picture film, "Keeping the Flag at Sea," by the Baltimore Dry Docks and Shipbuilding Company.

Moving picture display by the United States Shipping Board.

Moving picture display by the Todd Shipyards Corporation.

Moving picture display by the Camden Forge Company.

Moving picture display demonstrating the "Kitchen Patent Maneuvering and Reversible Rudders," by the Kitchen Reversing Rudder Company.

Moving picture display by the Submarine Boat Corporation.

THURSDAY, APRIL 15

Illustrated lecture on "General Conditions in the Philippines," by Mrs. Jaime C. de Veyra, for the Philippine Commercial Agency.

Moving picture of activities at Camp Sims—National Nautical School for the Boys of America.

Moving pictures and illustrated lecture descriptive of "Triple Safety Glass," by the Triple Safety Glass Corporation.

Moving picture display by the Camden Forge Company.

Moving picture display demonstrating the "Kitchen Patent Maneuvering and Reversible Rudders," by the Kitchen Reversing Rudder Company.

Moving picture display by the Todd Shipyards Corporation.

Moving picture display by the International Mercantile Marine Company.

Moving pictures and illustrated lecture on the "Gyroscope as an Aid to Marine Transportation," by the Sperry Gyroscope Company.

Moving picture display by the Columbian Rope Company.

FRIDAY, APRIL 16

Moving picture film, "Keeping the Flag at Sea," by the Baltimore Dry Docks and Shipbuilding Company.

Moving picture display by the United States Shipping Board.

Lecture by the American Red Cross (Insular and Foreign Division).

Moving pictures of cruise of the New York State Nautical Schoolship *Newport.*

Moving picture display by the Morse Dry Dock and Repair Company.

Moving picture and illustrated lecture by the De Vilbiss Manufacturing Company.

Moving picture display by the Astoria Boat Works.

Moving picture and illustrated lecture descriptive of "Triplex Safety Glass," by the Triplex Safety Glass Corporation.

Moving picture display of the "Poole Turbine and Gear Manufactured by the Ford Motor Company," Pool Engineering Company.

SATURDAY, APRIL 17

Moving picture display by the Department of Commerce.

Moving picture display by the International Mercantile Marine.

Moving pictures of cruise of the New York State Nautical Schoolship *Newport.*

Moving pictures of activities at Camp Sims.—National Nautical School for the Boys of America.

Lecture by Uttmark's Nautical Academy.

Illustrated lecture on the "Method of Recovering Sunken Cargoes and Raising Sunken Vessels," by the Argonaut Salvage Corporation.

Illustrated lecture describing the advantages of the commercial submarine boat and apparatus for commercial exploration and investigation, and in recovering the natural products of the sea. Also on their ability to materially shorten certain trade routes. By the Lake Engineering Company.

What Was Done on Special Nights

The programme for special nights and addresses in the lecture hall included:

MONDAY, APRIL 12—*Shipbuilding Night*

Address by Holden A. Evans, president of the Baltimore Dry Docks and Shipbuilding Company; subject, "Shipbuilding and the Merchant Marine."

Moving picture film, "Keeping the Flag at Sea."

Meeting of The Marine Press of America.

TUESDAY, APRIL 13

Welcome to Navy Men, by P. H. W. Ross, president of the National Marine League.

WEDNESDAY, APRIL 14—*Engineering Night*

"The Use of Boilers for Generating Steam," by Mr. Walter McFarland, of the Babcock and Wilcox Company.

"Queen of the Waves," a special film showing development of electric drive through all the stages of marine transportation. Mr. B. S. Beach, General Electric Company.

"Turbines and Turbine Reduction Gears," by Mr. P. M. Robinson, Westinghouse Electric & Manufacturing Company.

"Inland Navigation," by Mr. William T. Donnelly.

"Diesel Engines for Ship Propulsion," by Dr. C. E. Lucke.

THURSDAY, APRIL 15—*Travel Day*

Luncheon at Hotel Commodore, under auspices of Travel Club. Addresses on "Travels in the Land of Kublai Kahn," by Roy Chapman Andrews, and "With Peary at the Pole," by Captain Robert A. Bartlett.

"A Tour of the West Indies and the Panama Canal," by Mr. Henry Collins Walsh, president of the Travel Club of America. Illustrated with colored slides and with motion pictures of the Panama Canal loaned for this occasion by General George W. Goethals, builder of the canal.

Motion pictures of the building of American ships during wartime at the Virginia shipbuilding plant of the United States Steamship Company. These include pictures of President Wilson driving the first rivet in the keel of the first vessel built at the plant and the launching of the first vessel.

"Sumatra, Its People, Their Manners, Customs and Industries," by the Universal Film Company, New York. Motion pictures taken by a special expedition sent out by the company. This was its first showing.

"Mountaineering in Our National Parks," by Mr. LeRoy Jeffers, F.R.G.S., general secretary of the Associated Mountaineering Clubs of North America. Illustrated with colored slides of rare beauty, showing some little-visited sections of our wonderful parks.

FRIDAY, APRIL 16—*Fuel Night*

"Colloidal Fuel," by Lindon W. Bates, assisted by Dr. S. E. Shepherd, chief chemist, Kodak Research Laboratory, Rochester, N. Y.

"The Bunkering Problem of the American Merchant Marine," by Captain Paul Foley, United States Shipping Board.

"Coal and the Merchant Marine," by Mr. LeBaron S. Willard.

"The Story of Oil," a film loaned by the United States Bureau of Mines.

SATURDAY, APRIL 17—*Merchant Mariners' Day*

Welcome to Merchant Mariners, by P. H. W. Ross, president of the National Marine League.

Chantey singing by delegation from Sailors' Snug Harbor, Staten Island.

General reception to merchant mariners. Captain Arthur N. McGray, chairman of the committee.

Address by Governor Alfred E. Smith; subject, "The Need for a Merchant Marine."

Moving picture film, "Keeping the Flag at Sea."

Exhibits at the Marine Exposition

The list of exhibitors with their displays follows:

A

Admiral Anchor Company, 111 Broadway, New York.—Samples of the Admiral Stockless Anchor, of various sizes.

Alberger Pump & Condenser Company, 140 Cedar street, New York.—Alberger occluders, Wainwright feed water heaters, oil coolers, and expansion joints; Alberger Spiroflo condensers, centrifugal boiler feed pumps.

Allison Anchor Company, Chester, Pa.—Model of stockless anchor; anchor destroyed by acetylene torch and pulled to test of 12,000 pounds, or 8,000 pounds above Shipping Board test.

Aluminum Cooking Utensil Company, 1328 Broadway, New York.—Outfit of kitchen, and galley jacketed kettles and range utensils.

Amalgamated Bituminous Corporation, Pier 11, New York.—Bituminous compounds, for the interior of ships; rust and corrosion prevention.

Amalgamated Paint Company, Pier 11, North River, New York.—Ship paints, and anti-fouling composition; models of ships camouflaged.

American Car & Foundry Company, 165 Broadway, New York.—Three and five phase Berwick electric rivet heaters in operation.

American Clay Machinery Company, Bucyrus, Ohio.—Single drum, single geared, double cylinder reverse valve steam winch.

American Engineering Company, Philadelphia, Pa.—Electro-hydraulic steering apparatus, windlasses, cargo hoists, towing machines.

American Library Association, 31 West 15th street, New York.—Pictures, flags, books.

American Manganese Bronze Company, Holmesburg, Philadelphia, Pa.—Propellers of manganese bronze.

American Manufacturing Company, Noble and West streets, Brooklyn, N. Y.—Manila and sisal rope, marine cordage.

American Mast & Spar Corporation, 110 W. 40th street, New York.—Sticks, spuds, booms, post and columns and waterproof cloth.

American Seamen's Friend Association, 76 Wall street, New York.—Projection machine, and library on the steamer Roosevelt used by Peary on his trip to the North Pole.

American Ship Supply Company, 110 W. 40th street, New York.—Marine canvas work, masts and spars, ship chandlery.

American Standard Ship Fittings Corporation, 115 Broadway, New York.—Marine hardware, galley equipment, ventilators, and ship fittings.

American Steel Foundries, 30 Church street, New York.—Dunn stockless anchors.

Arnesto Paint Company, West 99th street, New York.—Anti-fouling compositions, ships paints.

Asbestolith Manufacturing Company, 1 Madison avenue, New York.—Fireproof, sanitary, germ-proof, non-corrosive floor coverings; cross section of floor and cover base without joints.

Astoria Boat Works and Equipment Company, 559 Boulevard, Long Island City, N. Y.—Life boats, small vessels, marine equipment, with models of life-saving boats.

Atlantic-Pacific Manufacturing Company, 124 Atlantic avenue, Brooklyn.—Life saving equipment, cork life belts and jacket-collar life preservers, buoys, Kapok jacket collar life preservers, water lights, fenders, etc.

Atlas Soot Blower Company, 101 Park avenue, New York.—Atlas soot blower for horizontal fire tube boilers.

Automobile Insurance Company, Hartford, Conn.—Beautifully decorated booth with a model of Columbus caraval Santa Maria, gilded.

B

Baker, H. W., Linen Company, 41 Worth street, New York.—Lighthouse, and display of linen and bedding.

Baltimore Dry Docks & Shipping Company, Baltimore, Md.—Large paintings of the yards, plant, buildings and ways.

Beaver Tile & Specialty Company, 44 Cliff street, New York.—Beaver colored cork tile, for decks.

Bendus, J. V., 39 Cortlandt street, New York.—Waterproof tent.

Benjamin Electric Company, 243 W. 17th street, New York.—Marine lighting and signalling apparatus, deck and bulkhead watertight fixtures.

Benson Electric Company, 2 Rector street, New York.—Non-glare flood lamp, electric steeromotor for motorships, flash lights, electric whistle and other appliances.

Bernstein Manufacturing Company, 3rd and Allegheny avenue, Philadelphia, Pa.—Berths, ship beds, bedding and metal furniture.

Boston Engineering Company, Boston, Mass.—Valves and model of Sturrock bridge walls.

Boucher, H. E., Manufacturing Company, 150 Lafayette street, New York.—Models of pleasure boats, engines, merchant vessels, and a torpedo boat destroyer.

Bowler, Holmes & Hecker Company, Inc., 259 Greenwich street, New York.—Electrically-driven pump, built for United States Government for use on battleships.

Bowman, M. K., Edison Company, 65 Dey street, New York.—Electric trucks, bullet tube brush, and photographs of interior of company's factories.

Boy Scouts of America, 200 Fifth avenue, New York.—Scouts in uniform showing operations at camps, wigwag systems, method of instruction, etc.

Bramhall, Deane & Company, 261 West 36th street, New York.—Ranges, kettles, cabinet ovens, urns, etc., for marine use.

Brandis & Sons, Inc., and E. S. Ritchie & Company.—Ritchie Compasses and Brandis Sextants.

Judson Brown Company, 30 Church street, New York.—Pumps, windlasses, chains and anchors, etc.

Brunswick Refrigerating Company, New Brunswick, N. J.—Refrigerating machinery and refrigerators, with compressor pump in operation.

Buzzini, Inc., Walter J.—505 West 21st street, New York.—Galley and pantry equipment.

C

Callaphone Company, Grand and Lafayette streets, New York.—Electric communicating systems, amplifying calls and picking up answers for stores, factories, etc.

Camden Forge Company, Camden, N. J.—Heavy forgings, thrust shafts, etc., for ship and engine builders.

Camp Sims.—Scene of part of the camp and nautical cadets.

Campbell, G. W., 253 Broadway, New York.—Cole course protractor, Erickson gas flue retarder, paddles, oars, handles.

Cashell Company, Marbridge Building, New York.—Koppax paint for preserving outdoor structural steel work.

Chadburn Ship Telegraph Company of America, Troy, N. Y.—Ship telegraphs and signalling apparatus, indicators and counters; Bassnett's sounding machine, and clear view screens for pilot houses.

Clothel Company, 61 Broadway, New York.—Refrigerating machine, and units for the use of ethyl chloride as a refrigerator.

Coen Company, 50 Church street, New York.—Machinery for the mechanical burning of oil in steam generation, valves, etc.

Columbian Rope Company, Auburn, N. Y.—Large coil of 10-inch rope weighing 3,200 pounds, other kinds and sizes of rope all having the private trade mark of red, white or blue line through the centre of the rope; display of unspun hemp; board showing various knots.

Cornell Emery Company, 25 Broadway, New York.—Ship furnishings and decorations, mattresses, curtains, upholstery, etc.

Cory, Charles & Son, Inc., 290 Hudson street, New York.—Electrical equipment, telephones, telegraphs, compasses, lighting fixtures, etc.; model of the first mechanical ship's telegraph ever built, invented December, 1862.

Cory, Herbert H., Inc., Norfolk, Va.—The Navy Stockless Anchor.

Crandall Engineering Company, East Boston, Mass.—Photographs of yards and dry docks, model steamer.

Cutler-Hammer Company, 50 Church street, New York.—Automatic truck and screen speed light controllers, reversing panels for submarine diving gear, motor starters, electric heaters, and other equipment; electrical melting pots.

Cutting & Washington Radio Corporation, 6 West 48th street, New York.—Radio apparatus.

D

DeLaval Separator Company, 165 Broadway, New York.—Centrifugal oil purifiers; motor-driven marine type in operation.

DeLaval Steam Turbine Company, 165 Broadway, New York.—Turbines, double helical speed reduction gears, turbine driven pumps, etc.

Department of Commerce, Bureau of Navigation, Lighthouse Department and Coast and Geodetic Survey.—Range finding radio exhibit, fourth class flashing light 37,000 candle power, radio distance and direction signalling, fog horns, all in operation; maps, charts of harbors, plates, copper and aluminum from which they were printed; life boats and life saving apparatus, channel flashlights operated by clock work and electricity and models of various vessels.

DeVilbiss Manufacturing Company, 1288 Dorr street, Toledo, Ohio.—Equipment for painting ships by the pneumatic spraying process.

Devoe & Raynolds Company, Inc., 101 Fulton street, New York.—Sample color sheets of marine paints and varnishes.

Dew Valve Company, 149 Broadway, New York.—Automatic relief valves for draining steam cylinders.

Diamond Power Specialty Company, Detroit, Mich.—Full size models of various types of soot blowers; model of Scotch marine boiler, sample of soot, test data, blue prints, photographs.

Dodge Sales & Engineering Company, 21 Murray street, New York.—Model of heavy oil internal combustion marine type engine; generator sets.

Domestic Electric Company, 52 Park Place, New York.—Delco-Lights for commercial and pleasure craft, showing method of installation and operation.

Donnelly, Wm. T., 17 Battery Place, New York.—Photographs, maps and plans.

Downey Shipyards, Arlington, S. D., N. Y.—Painting of New York harbor, models of engines, plans of shops, and models of ships.

DuParquet, Huot & Moneuse Company, 108 W. 22nd street, New York.—Electric oven, and other electric galley equipment.

Durkee Manufacturing Company, Inc., Grasmere, Staten Island, N. Y.—Nautical and airplane instruments, electrical apparatus and specialties.

E

Electric Arc Cutting & Welding Company, 222 Halsey street, Newark, N. J.—Portable alternating current welding devices, masks, shields, glasses, and other equipment

Electric Service Supplies Company, 17th and Cambria streets, Philadelphia, Pa.—Keystone turbo-generators, Golden Glow searchlights, footlights; Keystone contact rail material and guards.

Electric Tachometer Corporation, 35 North Broad street, Philadelphia, Pa.—Pedestal type bridge case, engine room counters, tachometers, marine equipment.

Electros Manufacturing Company, 60 Washington street, Brooklyn, N. Y.—Specimens of Electros insulation for electrical and mechanical purposes.

F

Falls Hollow Staybolt Company, 81 Fulton street, New York.—Specimens of hollow and solid staybolts for railroad and marine boilers.

Foamite Firefoam Company, 200 Fifth avenue, New York.—Illustrations of fire fighting process with specimens of apparatus, hand extinguishers, portable engines, and pails.

Fuller, George A., Company, Carolina Shipyard, Wilmington, N. C.—Models of ships, pictures, etc.

G

General Electric Company, Schenectady, N. Y.—Operation of the G-E arc welding set, steam driven generating sets, crank shafts, couplings, connecting rods, governors, piston valves, cylinder and stuffing boxes, cross section of engine showing forced lubrication type, and generator with direct connected exciter connected with steam engine; a two-plane geared turbine showing operation; other electrical equipment for maritime use.

Globe Shipbuilding & Dry Dock Company of Maryland, Baltimore, Md.—Models of ships and hulls Nos. 101, 102; model of yard with ships on ways, and dry docks.

Globe Car Heating Company, 17 Battery Place, New York.—Thermostatic heat regulating system in operation.

Gregory Galvanizing Works, Pittsburgh, Pa.—Galvanized cowls, stanchions, anchors, boilers, pipe fittings, chain, etc.

Guarantee Exterminating Company, 400 5th avenue, New York.—Masks used in fumigating ships, literature, etc.

H

Hamilton & Hansell, Inc., 13 Park Row, New York.—Automatic and hydro-hydraulic sal-log.

Hansen & Yorke Company, 88 Warren street, New York.—Dies and die stocks, chain hoists, bolts.

Hartman Company, Charles, 981 Dean street, Brooklyn, N. Y.—Deck and interior ventilators.

Hooven-Owens-Rentschler Company, Hamilton, Ohio.—Pictures, turbines, model of their plant.

Howden, James, & Company of America, Inc., Wellsville, N. Y.—Models of forced draft apparatus as applied to the four largest steamers in the world.

Hubbard, Charles, & Company, 81 Fulton street, New York.—Forgings, castings, staybolts, etc.

Hudson River Day Line, Desbrosses Street Pier, New York.—Models of Hudson River steamers.

Hyde Windlass Company, Bath, Maine.—Tower of graded sizes of manganese bronze propellers, windlass, winch, and hoisting equipment.

I

Industrial & Sales Corporation, 2 Rector street, New York.—G-O line throwing gun, and equipment, with method of operating shown.

International Flag Company, Jamestown, N. Y.—Brilliant display of flags.

International Mercantile Marine Company, 9 Broadway, New York.—Large models of the steamers *Kroonland* and *St. Paul*.

International Nickel Company, 43 Exchange Place, New York.—Samples of monel metal and nickel steel.

Irving Iron Works, Long Island City, N. Y.—Section of subway grating for wharves, stairs, floors, and engine room decks.

J

Jahncke Dry Dock & Ship Repair Company, Inc., New Orleans, La.—Photographs and pictures.

Jersey City, N. J.—Large model of proposed waterfront development.

Johannsen, H. S., 50 Church street, New York.—Winch driven by Skandia oil engine of 13 horsepower, 5,000 pounds on single line; engines from 9 to 500 horsepower and Werkspoor Diesel engines to 2,000 horsepower.

Johnson Shipyards Corporation, Mariners Harbor, S. I., N. Y.—Pictures of yard, small model.

K

K-G Welding & Cutting Company, 556 West 34th street, New York.—Welding and cutting units, blau-gas and oxy-acetylene cutters.

Kahnweiler's Sons, David, 260 Front street, New York.—Steel line throwing gun.

Kennedy, David E., Inc., 55 Fifth avenue, New York.—Everlastic floor tile, samples of artistic design and color.

Kidde, Walter, & Company, 149 Cedar street, New York.—Models showing the Rich system of fire detection and extinguishing on board ship.

Kingsbury, Albert, Oliver Building, Pittsburgh, Pa.—A 14-inch marine Kingsbury thrust bearing, and ordinary multi-collar horseshoe type bearing on a single shaft, mounted for friction tests and comparisons; 23-inch bearing arranged for detailed examination.

Kitchen Reversing Rudder Company, Ltd., Liverpool, England.—Reversing rudder in operation on electrically propelled model in large tank.

L

Lake Engineering Company, New London, Conn.—Model of ship and tanks, with birds and mice living in glass diving bells.

Lehigh University, Bethlehem, Pa.—Pamphlets and data on ship construction and marine transportation, with curriculum of engineering school and pictures.

Leslie Company.—Leslie pressure regulators and valves.

Lovell & Company, Arlington, N. J.—Lighting fixtures.

Lidgerwood Manufacturing Company, 96 Liberty street, New York.—Automatic tension towing engines, 16-inch drum steam winch, electric cargo winches.

Linotol Flooring Company, Inc., 15 Whitehall street, New York.—Plastic flooring material.

Locomotive Superheater Company, 30 Church street, New York.—Four-furnace model Scotch marine boiler in vertical section showing location of fire tube, superheater units and headers; horizontal section marine boiler; pyrometer; forged returned bend in several sizes and sections.

Luckenbach Steamship Company, 44 Whitehall street, New York.—Model of steamship *Louis Luckenbach* with side cut out showing cargo and storage space.

Lunkenheimer Company, 120 Lafayette street, New York.—Oil cups, valves, whistles and engineering specialties.

Lybeck Ocean Harvester Company, Inc., 134 W. 36th street, New York.—Model of an ocean harvester; fish catching by wholesale.

M

McNab Company, Bridgeport, Conn.—Octopus lubricator, engine room counters, log meters, ship's hardware and other equipment.

Mack Engineering & Supply Company, 123 Liberty street, New York.—Mackcaps staybolt nut protectors, Mack H. T. cement for high temperature brick work.

Mallory Industries, Inc.—Wireless equipment, ventilating turning gears, heaters, washing machines and electrical apparatus.

Marine Works, The, 31 Coenties Slip, New York.—Galley and cabin outfits, heavy marine hardware, sheet metal work and oil burners.

Maritime Hydraulic Oil Service, 101 Broadway, Detroit, Mich.—Model of application of Farr hydraulic oil system.

Merchant Shipbuilding Corporation, 120 Broadway, New York.—Photographs of Harriman and Chester, Pa., yards, and vessels on ways.

Mott, J. L., Iron Works, Trenton, N. J.—Marine plumbing fixtures.

Mississippi Wire Glass Company, 220 Fifth avenue, New York.—Port and deck lights, specimens of wire glass for port holes.

Morse Dry Dock & Repair Company, Brooklyn, N. Y.—Model of yards, showing dry docks with vessels floating, and out of order; large model of steamer *Mauretania*; and smaller models of various types; daily paper of exhibition.

Munson Steamship Line, 82 Beaver street, New York.—Models of steel steamships *Luristan*, *Tarbarista* and *Munamar*.

N

Navigator Log Corporation, Park Row Building, New York City.—Automatic navigator log.

National Hoisting Engine Company, Harrison, N. J.—Heavy duty ship winch, built on duplicate part system, with complete spares in stock.

Neptunus Ship Supply Company, 73 Front street, New York.—Erfman boiler water controller to determine amount of soda ash needed to keep boilers free of oil, grease, deposit and corrosion.

Newburgh Shipyards, Inc., Newburgh, N. Y.—Model of steamer *Olancho,* built for Cuyamel Fruit Company; large painting of the company's first vessel for the Shipping Board, the *Newburgh;* model of old Chinese water carrying junk.

City of New London, Conn.—Views of the city, and folders showing views, including Ocean Beach.

New London Ship & Engine Company, Groton, Conn.—Models of heavy duty marine type Diesel engines, with reverse gears.

New Process Chemical Company, 39 Cortland street, New York.—Marine glues, paints, hull seam composition.

New York Eingineering Company, 2 Rector street, New York.—Marine watertube boilers.

New York Marine Engineers' Beneficial Association, 26 Park Place, New York.—Flags and literature, model of cruiser *Iowa;* pictures of cross section of *S. S. Agamemnon* with reciprocating engines, and *S. S. Turbui.*

Nicholas Power Company, 88 Gold street, New York.—Cameragraphs and motion picture projection machine details.

O

Ocean Paint Works, 16 Whitehall street, New York.—Mermaid marine paints; fillers, paints and oils for use on shore.

Ohio Body & Blower Company, Cleveland, Ohio.—Swartwout Admiralty ship cowls, turning gears and other fittings.

Oriental Navigation Company, 39 Broadway, New York.—Model of one of the Donald Line steamers taken over by this company.

Oxweld Acetylene Company, 30 East 42nd street, New York.—Apparatus for cutting and welding of metal by the oxy-acetylene process, with specimens of work. The company distributed a booklet on permitted welding applications which should be used for reference in all shipbuilding yards.

P

Page Steel & Wire Company, 30 Church street, New York.—Armco iron rods and wire for oxy-acetylene and electric welding, and ingot iron wire for mechanical welding.

Paige & Jones Chemical Company, 15 East 40th street, New York.—Clarion paint oil for mixing with dry red lead without linseed oil.

Pantasote Company, 11 Broadway, New York.—Ship's cabin built of vehisote, furnished and illuminated.

Peterson, K. G., 29 Flatbush avenue, Brooklyn.—Marine photographer; exhibit of deep sea photographs, etc.

Philippine Commercial Agency, Grand Central Palace, New York.—Agricultural, forestry, mineral and oil products of the Philippine Islands.

Pioneer Metallic Packing Company, Inc., 150 25th street, Brooklyn, N. Y.—Metallic packing for cylinders, with split cases for installation or repairs without disconnecting rods.

Pneumercator Company, 15 Park Row, New York.—Draft gages, tanks, upright and horizontal, indicators for marine and land use.

Poole Engineering Company, Baltimore, Md.—Circulating pump, turbine-driven gear, centrifugal pumps used for collecting water for condenser, 30 horsepower turbine reduction gear, 62 horsepower; refrigerating machine ½-ton capacity, using ethyl chloride.

Port of New York Society, 166 Eleventh avenue, New York.—Model of old-style full rigged ship.

Power Specialty Company, 111 Broadway, New York.—Foster superheater for installation in boiler uptakes.

R

Ramsay Company, 140 Cedar street, New York.—Model in action of patent anticipating marine engine governor.

Reading Valve & Fittings Company, Reading, Pa.—Steel fittings, valves, flanges, etc.

Reid & Company, John, 30 Church street, New York.—Models of forced draft equipment for marine work.

Richmond Engineering Company, Richmond, Va.—Plate, bar and sheet metal products, universal terminals for ship ventilation.

Row & Davis, 91 West street, New York.—Paracoil evaporators, feed water heaters, fresh water still, feed water filter and grease extractor.

S

Schutte & Koerting Company, Philadelphia, Pa.—Humidifiers, pumping outfits, steam or belt driven; ventilating apparatus, feed water heater, bilge syphons.

Shipping Board, Division of Operations—Relief map of the world, 38 by 15 feet, showing trade routes and vessel lines. The Emergency Fleet Corporation—Model 1/10 size of 13,000 deadweight ton cargo and passenger ships (the vessel of which this is a model was described in detail in the April issue of Marine Engineering), models of vessels from the *Clermont* to the modern liner, showing the progress of steamship construction. Supply and Sales Division, samples of surplus and salvage material, equipment tools, etc., on sale. Catalogues on application.

Shonberg, I., 122 Flushing avenue, Brooklyn, N. Y.—Samples of babbit metal, line shaftings, etc.

Simpson Gordon Patents, Inc., 17 Battery Place, New York.— Model of steamers being built at the Newburgh Shipyard, showing bilge tunnels carrying main shafting, and the Simpson topside water ballast tanks.

Sinclair Oil Refining Company, 120 Broadway, New York.—Samples of oil.

Skinner & Eddy Corporation, Seattle, Wash.—Models of standardized ships built by the company.

Standard Oil Company, 26 Broadway, New York.—Picture of Grand Canyon of the Colorado.

Staten Island Shipbuilding Company, Staten Island, N. Y.—Model of shipbuilding yard and models of vessels built by the company.

Steward Davit & Equipment Company, 17 Battery Place, New York.—"Mutt" and "Jeff" Davits, life boat and full equipment of apparatus for saving life at sea.

Sturrock Furnace Bridge Wall Company.—Furnace bridge walls for boilers, pump valves, etc.

Sturtevant Company, B. F., Hyde Park, Boston, Mass.—Generating sets, blowers, etc.

Submarine Boat Corporation, 5 Nassau street, New York.—Large detailed model of Newark Bay Shipyard; model of 5,350 deadweight tons standardized ships, 7 feet long, and other vessels.

T

Tacony Steel Company, 2 Rector street, New York.—Heavy marine forging, piston rods, bars, billets, etc.

Texas Company, 17 Battery Place, New York.—Petroleum products.

Thorne-Pioneer Company, Inc., 3 Atlantic avenue, Brooklyn, N. Y.—Metallic packings for marine and stationary engines, steam pumps and compressors.

Thorsen, P. S., & Company, Inc., 81 Coffey street, Brooklyn, N. Y.—Vitribestos sheet and cement for steam pipe and boiler covering; asbestos insulations.

Tiebout, W. & J., 118 Chambers street, New York.—Caldwell sash balances, and marine hardware.

Todd Shipyards Corporation, 15 Whitehall street, New York.—Model of Tacoma, Wash., repair plant, large model of modern ocean liner in six-section floating dry dock in the Robins yard in operation, vessel being floated and lifted out of water; models of marine engines, steam yachts, and vessels built at the various plants of the corporation; oil burning engines and equipment.

Topping Brothers, 122 Chambers street, New York.—Heavy marine hardware, shipbuilders', contractors' and railway supplies.

Triplex Safety Glass Corporation, 1778 Broadway, New York.—Safety glass for port holes, sighting panels, and other purposes.

Turbine Air Tool Company, Cleveland, Ohio.—Air tools run by turbines in action.

U

Union Sulphur Company, 17 Battery Place, New York.—Samples of sulphur.

United Marine Contracting Corporation, 15 Whitehall street, New York.—Automobile truck carrying electric welding apparatus.

United States Navy Department.—Models of old and new war vessels, from battleships to torpedo boat destroyers, battery of three torpedo tubes, torpedo, radio service, models of powder charges and projectiles, naval guns, cross section of battleship, paravane, relief plan of New York harbor and ap-

proaches showing lighthouses, channels and moving vessels, mines, anti-air craft and rapid fire gun; samples of tools, hardware and equipment, and other surplus material to be sold.

United States Steamship Company, United States Transport Company, 50 Broad street, New York.—Models of ships, pictures, maps of shipyard at Alexandria, Va.

Upson Walton Company, 291 Broadway, New York.—Anchors, nautical instruments.

V

Valentine & Company, 456 Fourth avenue, New York.—Marine paints, enamels, brass polish preservative for exterior and interior of ships.

Van Nostrand Company, 25 Park Place, New York.—Military and Naval Books, Nautical Manuals.

Virginia Iron Works, Norfolk, Va.—Ship repair facilities.

Vulcan Iron Works, Inc., Jersey City, N. J.—Models of marine engines and boilers, the Parsons marine steam turbine.

W

Wager Furnace Bridge Wall Company, 149 Broadway, New York.—Models of improved furnace bridge wall.

Wales, Dove-Hermiston Corporation, 17 Battery Place, New York.—Bitumastic and hermastic paints, coatings and enamels.

Wall Rope Works, Inc., 48 South street, New York.—Cordage of all sizes, unspun hemp; Manila hawser 23 inches in circumference, 720 feet long and 5 tons weight.

Waltham Watch Company, Waltham, Mass.—Exhibit of clocks and watches.

Ward Line, foot of Wall street, New York.—Pictures and flags.

Waterbury Company, 63 Park Row, New York.—Cordage of all sizes, unspun hemp; fibre clad wire rope.

Westinghouse Electric & Manufacturing Company, 165 Broadway, New York.—Models of turbines, reduction gears, and other electrical machinery for use at sea; also Diesel electric equipment.

White & Company, Kelvin & Winfred O.—White liquid compass, Lord standard compass, electrically illuminated; pelorus.

Whitlock Cordage Company, Jersey City, N. J.—Manila and sisal rope, plain and tarred; solid and hollow wire rope.

Williams Valve Company, D. T., Cincinnati, Ohio.—Valves of all sizes.

Williams, Wm. E., 62 Front street, New York.—Valves, lubricators, grease cups, electrical drill and grinder, etc.

Wilson Welder & Metals Company, 2 Rector street, New York.—Plastic arc welding units, pyrometers.

Winner Company, 30 Church street, New York.—Steam traps for automatic removal of condensation, or water without waste of steam.

Wireless Improvement Company, 47 West street, New York.—Radio compasses, radio pack sets, arc transmitter, aero type radio equipment.

Worthington Pump & Machinery Corporation, 115 Broadway, New York.—Air compressors, power pumps, condensers, and auxiliary equipment.

Periodicals having booths at the exposition included Marine Engineering, *Marine Journal, Marine News, Maritime Register, Shipping, Nautical Gazette, Motorship, Shipbuilding Cyclopedia, Shipbuilding and Harbor Construction* (Canadian), *Marine Review, Motorboating,* and *Merchant Marine Manual and Yachtsman's Guide.*

Other booths were occupied by the Travel Club of America, Neptune Association, National Marine League, Seamen's Service Centre, American Red Cross, Young Men's Christian Association, Shipmasters' Club, National Merchant Marine Association, Naval Recruiting Station, Smith's Port of New York Annual, Uttmark's Nautical Academy, American Bureau of Shipping, Seamens Christian Association, W. A. Harriman & Company.

Lloyd's Shipbuilding Returns

LLOYD'S annual shipbuilding return for the past year, which take into account only merchant vessels of 100-tons gross and upwards, that were launched during the year show that the total output during 1919 has been 7,144,549 tons, which is an increase of 1,697,000 tons, as compared with 1918, and 3,811,000 tons more than the output for 1913, which was the pre-war record year.

The countries having the largest amount of tonnage under construction at the end of 1919 are: United States, 2,966,000 tons; United Kingdom, 1,620,442 tons; Holland, 328,000 tons; Italy, 314,000 tons; and Japan, 309,000 tons.

The output in the United States, namely, 4,075,385 tons, is 1,042,000 tons higher than during 1918. The whole of the increase is due to the larger amount of steel steam tonnage launched during the year, which reached about 1,431,000 tons more than during 1918. The wood tonnage, on the other hand, has decreased by nearly 415,000 tons, and is under 13 percent of the total output of the United States as compared with over 31 percent for 1918.

(*Photograph by U. S. Air Service from International*)

Remarkable Photograph of the United States Battleship *Maryland*, Taken from an Aeroplane Just After the Vessel Was Launched by the Newport News Shipbuilding & Dry Docks Company, Newport News, Va., on March 20

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Two Years of Electric Propulsion on the New Mexico

As the *New Mexico,* the first United States battleship to be fitted with electric drive, was placed in commission at the New York Navy Yard in May, 1918, she is now just completing her second year of active service. During that time she has seen service of practically every kind that is encountered by a battleship except actual engagement in battle. The results of this service, according to Commander S. M. Robinson, U. S. N., fleet engineer of the Pacific Fleet, of which the *New Mexico* is the flagship, have been highly satisfactory and justify the judgment of those who are responsible for the installation of electric machinery in the vessel.

As Commander Robinson gave a very complete description of the *New Mexico's* machinery in this magazine a year ago, it will be remembered that the electric machinery for propulsion consists of two main turbo generators rated at 11,500 kilowatts each at 80 percent power factor and having an overload capacity of 25 percent, four main motors rated at 7,250 horsepower each and having an overload capacity of 25 percent, two boosters for varying the current of the main field, two 300-kilowatt exciters for supplying the current to the main field and also certain electrically-driven auxiliaries, together with a main switchboard, an exciter switchboard and the necessary wire and cable. The ship uses one generator for speeds up to 17 knots and two generators for speeds from 17 knots to full speed, which is between 21 and 22 knots. For speeds up to 15 knots the motors are run on the 36-pole connection, so that at 15 knots the turbine is running at its designed full speed; from 15 knots to full speed the motors are run on the 24-pole connection. This arrangement gives good economy at all speeds, and in order to give our readers a definite idea of just what results have been obtained, Commander Robinson has prepared the following report:

The *New Mexico* has been operating for nearly a year in company with two sister ships, the *Idaho* and *Mississippi,* which have hulls identical with that of the *New Mexico.* During this time it has been possible to get an accurate comparison of the relative economy of the three ships and also the relative maneuvering qualities. In the latter respect, the *New Mexico* is decidedly superior, and the remarkable part of it is that nearly all the maneuvering in restricted waters has been done with one turbogenerator. When this installation was first proposed, its opponents maintained that, while a ship like the *Jupiter* could be satisfactorily operated with the screws on both sides of the ship running at exactly the same speed, it would not be possible to get satisfactory operation with that arrangement on a ship which had to operate in formation. But exactly the reverse has proved to be true; it has been found that more satisfactory operation is obtained when using one generator than when using two, and it is customary, when in dangerous waters where it is desired to take all possible precautions, to use one generator for driving the ship and to keep the other turning over idle. If the ship is getting under way from an anchorage and has to turn, as soon as the anchor is away the signal is given for standard speed ahead on one side and the same speed astern on the other; with this arrangement the ship will turn absolutely on her heel without gaining ground either ahead or astern; with other engines, where it is not possible to regulate the speed so quickly and accurately, the probability of getting speed on the ship in one direction or the other is much greater. All the predictions in regard to trouble on account of the condition that when operating with one generator the screws on both sides of the ship must run at the same speed (if run at all) have proven to be groundless.

In regard to the comparison of economies the results have been very favorable to the *New Mexico.* The *Idaho* and *Mississippi* are fitted with direct-connected turbines (one is Parsons and the other Curtis) and have geared cruising turbines; the *Idaho* can use her cruising turbines at all speeds up to about 17 knots and the *Mississippi* can make about 15 knots with her cruising turbines. Experience gained by a comparison of destroyers fitted with geared main turbines and those fitted with direct-connected main turbines and geared cruising turbines indicates that the economy of the *Idaho* and *Mississippi* at cruising speeds is about as good as it would be if they had geared main turbines. A comparison of the *New Mexico* with these ships is therefore particularly interesting at the lower speeds.

The advocates of electric propulsion have always claimed that it was very superior to all other forms of propulsion at the cruising speeds, but even the most enthusiastic of these have been surprised by the remarkable showing made. This is doubtless due to the fact that no one made sufficient allowance for the saving due to shutting down one generator and all the auxiliaries that go with one of the condensing plants. At a speed of 10 knots the *New Mexico* uses about 16.7 percent less oil than her sister ships, or, putting it another way, her sister ships use about 20 percent more than the *New Mexico*; at 13 knots the figures are 29.9 percent or 42.7 percent; at 16 knots the figures are 32.3 percent or 47.8 percent; at 19 knots the figures are 28.6 percent or 40.1 percent; at full power the figures are 24.4 percent or 32.2 percent.

At 19 knots and also at full power the *New Mexico* uses about .975 pound of oil per shaft horsepower, and at 15 knots she only uses 1.1 pounds of oil per shaft horsepower. This is a remarkably uniform economy.

The *New Mexico* has just completed her annual full-power trials and the following table gives an analysis of the data obtained:

	Full Power	Endurance
Revolutions per minute	167.4	151.7
Speed (knots)	21	19.35
Shaft horsepower	28,820	21,650
Pounds of oil per shaft horsepower per hour	.975	.973
Pounds of oil per square foot of heating surface	.506	.3795
Estimated water evaporated in pounds per hour	393,500	294,700
Estimated water per shaft horsepower in pounds per hour (all purposes)	13.65	13.62
Pressure (gage) in pounds per square inch at the boilers	270	265
Pressure (gage) in pounds per square inch at the turbines	255	260
Superheat (in degrees Fahrenheit)	32	23
Vacuum	28.7	29.0

In regard to the reliability of the machinery, the *New Mexico* has had nothing but the most minor troubles with her electric plant and there have been no navy yard repairs whatever; there has been one serious accident to the steam part of the machinery which required work to be done by a navy yard, but that was due entirely to a mechanical defect. Due to improper construction of the main governor, one of the weights became detached while the turbo-generator was running without load; the turbine ran away and operated the emergency governor, which tripped the throttle, but the latter did not entirely close and the turbine ran at over-speed sufficiently to stretch the turbine wheels and the entire rotor had to be replaced. The governor has been changed and additional over-speed protection given by arranging for the emergency governor to close the admission valves as well as the main throttle. The machinery has been in operation nearly a year since repairs were completed and no further trouble has developed.

In conclusion, it may be said that the performance of the *New Mexico* since commissioning has been entirely satisfactory in every way and that the expectations of those who were responsible for its installation have been more than realized.

A Remedy for the Shipping Situation

In a letter just received from Robert Dollar, head of the Robert Dollar Steamship Lines, the following remedy is proposed for the present shipping difficulties:

"First, change our laws and regulations so as to put our shipowners on an exact equality with their foreign competitors.

"Second, authorize the Shipping Board to sell our ships at the same price as our competitors are paying."

When these two simple propositions are put into effect, Mr. Dollar is confident that we will have a merchant marine in reality.

Mr. Dollar's recommendations are based upon a lifetime's experience in the shipping business and upon a full knowledge of actual conditions as they exist. In the coastwise trade, he says, where the Government can legislate to charge any rates it pleases, the ships can be operated, but in the foreign trade, where competition must be met from every nation which has organizations in every port versed in shipping and backed up by their banks, our Government, powerful as it is, is doomed to failure.

As to the price at which Government-owned vessels should be sold, Mr. Dollar cites a case in which his Canadian company bought two ships from the British Government. This was in October, 1919. One vessel was a twin-screw, 14-knot ship of 13,750 tons deadweight, two years old, which was bought for $111 a ton, and the other a single-screw, 13-knot vessel of 10,750 tons deadweight, one year old, which was bought for $104.50 per ton. If a Shipping Board vessel of, say, 10,000 tons deadweight had been bought for $220 a ton, the difference in price, as compared with a British duplicate, would have been $1,155,000, and in operation the higher-priced American vessel would have had to overcome charges amounting to $195,585 above those required for the British ship. Not only would this difference have to be overcome in order to compete with foreign vessels, but the American ship would also have to carry a 30 percent larger engine room force and pay about 25 percent more tonnage dues and charges on account of the difference in measurement of the competing ships. Other differences must also be reckoned with before the competing vessels are placed on a basis of equality, and it is in view of these at present insurmountable handicaps that Mr. Dollar proposes his remedy.

The Sale of Government Ships

While the recent conferences of heads of large business enterprises of the Middle West on a Shipping Board sales policy was disappointing in that no definite recommendation was made, there were two distinct developments at the meeting which may prove beneficial in establishing an American merchant marine. The first was the unanimous agreement of the members of the conference that the Shipping Board should adopt a scale of prices that would result in the sale of the Government ships to private companies and at the same time protect the investment of the public to the largest extent possible. And the other was the appointment of a committee under the direction of Eugene Meyer, managing director of the War Finance Corporation, to consider means of financing the disposal of the ships.

The sense of the conference was expressed in a resolution that the Board should sell its ships on terms which would assist in the permanent establishment of the merchant marine. It was generally agreed that this should be on the basis of the cost of reproduction less depreciation for age and plus a fair figure for immediate delivery. Among the suggestions which will be considered by the finance committee for submission to the Shipping Board is the formation of a corporation similar to the Railway Equipment Finance Corporation formed by the Railroad Administration to finance the sale of Government equipment to individual railroads. As a result of the difficulty of obtaining funds on reasonable terms for shipping companies, it was realized that a plan should be devised whereby Government credit should be used to assist private companies, but without the need of a further Government expenditure.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Average Life of Punches and Dies

The chart, Fig. 1, shown herewith, was made up from records kept of the number of holes punched by each of several score of punches, together with the thickness of material punched.

Very few of the punches were repaired, as in nearly all cases when a punch broke the fracture was so close to the head that the punch was beyond repair.

In the few cases where a punch could be repaired it was retempered and put back into service. In the chart no account is taken of the repairing, the total number of holes punched up to the time the punch was totally destroyed being the number used in making up the record.

The punches were not all of the same make, and no attempt was made to compare the production of the different manufactures, as it was felt that the conditions under which these tools work are too variable to afford any just criterion of the merits of any one punch.

The records were made from the output of about twenty punches of each size, working on stock material just as it happened to come through the shop. In nearly all cases each punch was used on one thickness of steel.

The quality of steel was in all cases the standard structural steel, and the dies were all 1/16 inch larger in the hole than the diameter of the punch.

The punching was done on a variety of machines, all in fair average working condition, no attempt being made to reach a record number of holes per punch, the idea of making the test being to get a line on what life might be expected from a punch under everyday conditions.

The points in the chart marked with a + represent the average number of holes punched by the punches of the size marked, in the thickness of material shown on the chart. These points are shown connected by straight lines for each individual size of punch.

The table accompanying the chart gives the average number of holes punched by all the punches of each size in all thicknesses of steel. These averages are totaled up and again averaged to show the mean output of all sizes of punches in all thicknesses.

As is well known, the life of punches, even of the same size and working on the same thickness of material, will vary from a few holes up to 20,000 or more. But when it is required to estimate the future needs, this chart will afford a fairly accurate idea as to the number of punches necessary to complete a certain piece of work.

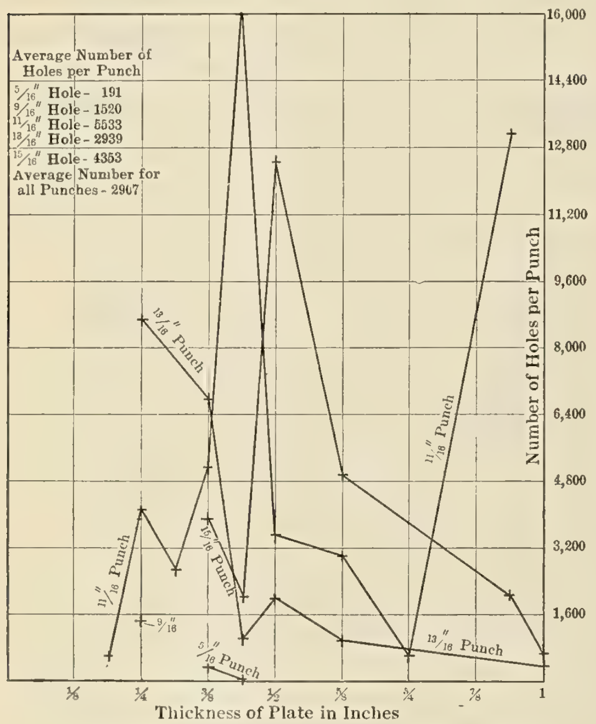


Fig. 1.—Chart Showing Average Life of Punches

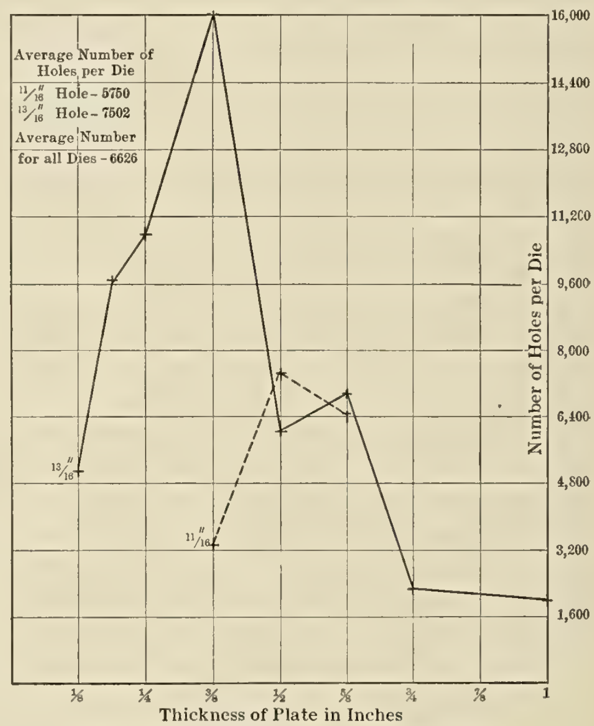


Fig. 2.—Chart Showing Average Life of Dies

It is interesting to note the marked similarity of the curves for the 11/16-inch and 15/16-inch diameter punches. These show that we can expect the longest life when working on 7/16-inch to ½-inch plate, and that on either thicker or thinner steel the production per punch falls off very rapidly.

The chart shows the life of an 11/16-inch punch in

15/16-inch steel to be 13,000 holes, but this particular number represents the record of only one punch, and is really a rather remarkable performance. If the average life of a number of this size of punch in 15/16-inch steel were available no doubt this quantity of holes per punch would be very considerably less.

The comparatively short life of the 11/16-inch and 15/16-inch punches in thin plates is probably due to the tendency of the plates to stretch under the punch and flow into the die thus jamming the punch.

It would probably be conducive to a longer life of the punch if the die were made only 1/32 inch larger than the punch when working on steel of a thickness of ⅜ inch or under.

Whether this saving in punches would pay for the extra cost involved in handling two sizes of dies for each size of punch will depend upon the kind of work being handled.

Fig. 2 is a similar chart for dies, and what has been written above in reference to the punches is equally applicable to the dies.

New Glasgow, N. S. John S. Watts.

Scientific Management on Shipboard

Long since, the progressive and successful business man has instituted as a supplementary arm to his regular organization the services of various specialists. Aside from the fact that modern organizations continue this form of service, the fact that the number of firms offering specialized service is rapidly increasing proves that scientific management is very successful indeed.

At the present time the question of the future of the American merchant marine is one of vital importance to everyone in this country. This is a rather broad statement, but it is nevertheless true that every one is concerned, if not directly then indirectly. Operating expenses must be cut to a minimum in order to compete with foreign bottoms. Penny-wise-and-pound-foolish methods must go into the discard. During the war, equipment was standardized as far as possible, consistent with available deliveries, to meet emergency conditions. The object was to make a ship's power plant as simple and foolproof as possible. Now that the emergency is past, why not standardize methods of routine operation? If scientific management pays dividends ashore, why will it not be a paying investment afloat? The purchase of a few instruments and the services of a man familiar with marine operation, who has had scientific training, to instruct the operating force of the ship in their use and who would make a voyage with the ship and lay out a working schedule with the co-operation of the operating chief from the observations made during the trip would be a paying investment to the owner, in the writer's opinion.

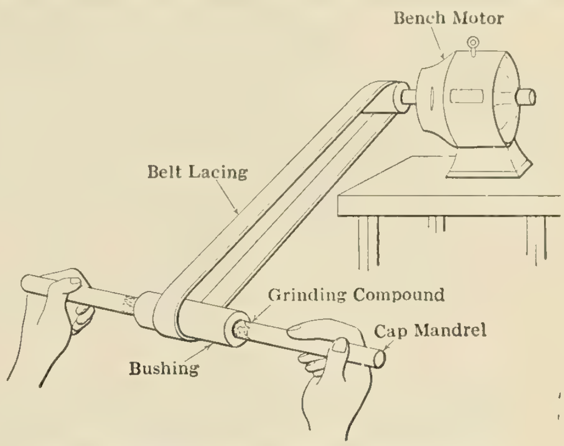
It has been asserted to the writer that the average operating man would not be inclined to co-operate with a specialist in this class of work; but the writer is of different opinion, having been one of the tribe. He can recall an attempt of rough efficiency work on board a well-known liner some twenty years ago. It consisted of the watertender standing on a coal pile in the fireroom and blowing a whistle every time it was necessary to slice fires, calling for odd or even numbered furnaces. Another instance was an old chief who had a set time for overhauling every piece of equipment and kept a record of it. It included valve grinding. That old chief never was caught in a jam at sea; he simply didn't wait for it to happen.

The object of this letter is to create discussion among those interested as to whether or not in their opinion scientific management can do for the power plant afloat what it has done successfully on land. If it can, are we going to let tradition stand in the way of doing our part towards placing the Stars and Stripes on all seas and in maintaining our present state of prosperity?

Long Island City, N. Y. A. Pohlmen.

Lapping Bushings

Here is a simple stunt employed by one of the repair men in our plant to lap in undersized bushings. He obtained a piece of cold rolled round stock of correct diameter and coated the center of it with a heavy mixture of



Handy Method for Lapping Undersized Bushing

compound (emery and cylinder oil) and slipped the undersized pushing over it. As shown in the sketch herewith, by the aid of a belt lacing made into a small belt and a small bench motor, the bushings were quickly lapped to size. This scheme can be employed to good advantage on pulleys, etc., which were found undersized for shafts.

Engineer.

Wooden Sectional Floating Dry Dock

I have read with much interest the article by Mr. Carl E. Peterson on "Wooden Sectional Floating Dry Docks" in the March issue of Marine Engineering and would like to comment on certain statements made therein.

Under "Design and Construction," Mr. Peterson states: "The members of the sections are larely determined empirically and from good practice." Such design usually results in the size of the members being entirely out of proportion to the stresses they are to carry. Frequently these members are much larger than required, and at the same time the joints and connections so proportioned that they can only develop a fraction of the strength of these timbers. This results in needless and excessive first cost and a limited period of service before the dock becomes too limber for safe use. In these times, with the great advancement in engineering, we should be beyond the stage of designing such structures by guess. The forces acting on a floating dock are most definite, and include the weight of the ship on the keel and bilge blocks, the weight of the dock itself, and the upward pressure of the water on the bottom of the dock. With these definite forces to take care of, stress diagrams may readily be drawn, the stresses to which each member will be subjected calculated, and the sizes then determined in accordance with good engineering. Such design results in as-

sured safety, a longer lifetime, a minimum of material, and a minimum cost. In a floating dock, proper design is as important, if not more important, than good workmanship. Both are essential.

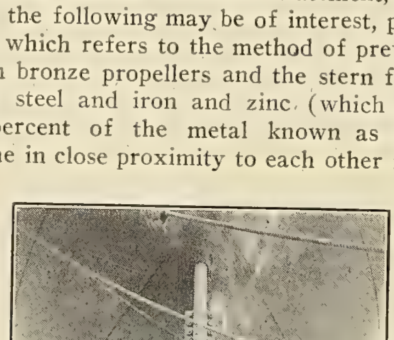
From the subject matter I would assume that Mr. Peterson's remarks cover only the loose-sectional dock. Comparison as to cost is only made with the all-steel floating dock and the graving dock. In the article no mention is made of the effect on the ship in docking in a loose-sectional dock. Anyone who has watched such a dock in operation appreciates that there are frequently wide variations in the rates of pumping and thus in the water levels in the several sections. This results in unequal uplift, all of which must be taken by the ship, causing undue stress and distortion thereto. Self-docking types, such as the longitudinally-trussed sectional dock and the continuous wing-separate pontoon dock, which are usually built of all timber or with timber pontoons and steel wings, do not have this objectionable feature, for the reason that they are designed to withstand longitudinal bending moment as well as lateral bending moment, and thus take care of irregularities of pumping and inequality of load distribution. The former type costs practically no more and the latter but little more than the ordinary sectional dock, and they have practically all the advantages and none of the disadvantages of this type.

East Boston, Mass. J. Stuart Crandall,
The Crandall Engineering Company.

A Suggestion for the Chief Engineer

You have heard it said that the bronze propellers eat away the stern frame of a steel ship. You probably are familiar with the reasons for such a statement, but in case you are not the following may be of interest, particularly that portion which refers to the method of preventing action between bronze propellers and the stern frame.

Whenever steel and iron and zinc (which constitutes about 40 percent of the metal known as manganese bronze) come in close proximity to each other in a liquid,



Position of Propeller

such as salt water or impure water of any character containing light acids, sewage, etc., an electric battery is created, the action of which is known as galvanic action. This causes the zinc and the iron in very finely divided particles to detach themselves from their respective bodies, thus in time causing noticeable ruptures in the surface of the material.

There is a definite point of distance between two such bodies of metal where the galvanic action ceases, and to prevent the action it is necessary to separate the metals by a greater distance than the minimum referred to.

Practically the entire damage that might occur to the stern frame of a bronze propellered ship occurs when the ship is lying in port and in waters that are decidedly aciduous in composition. In an attempt to overcome this action, zinc plates are many times fastened on the stern frame, and by such an installation of zinc plates the zinc in the bronze is not acted upon, nor is the steel in the stern frame. A better way, however, to reduce the action is to separate the bronze blades from the stern frame by stopping the shaft so that the blades will be in a position farthest removed from the frame. We suggest that you mark your shaft in such a way that when it is registered with any stationary point you may select, the blades are in the position desired, as shown in the illustration, and that whenever you are in port you make it a rule invariably to rest your engine in this position. This will practically eliminate the galvanic action referred to and give greater life to the ship.

This information is furnished by the Columbian Bronze Corporation, manufacturers of Columbian Propellers, 50 Church Street, New York City, in the interests of efficient ship operation.

The Eventful Maiden Voyage of the S. S. William Henry Webb

So many misleading stories regarding the difficulties encountered by the S. S. *William Henry Webb* (a steel freighter of about 8,800 tons deadweight capacity, built at the Chester, Pa., yard of the Merchant Shipbuilding Corporation, and propelled by Westinghouse geared turbines of 3,000 shaft horsepower) on her maiden trip from Philadelphia to New York have been circulated that the following facts will be of interest to marine engineers.

The ship had passed her trials very satisfactorily and was on her first voyage from Chester, Pa., to New York. Off Atlantic City a stop was made to replace the thrust bearing shoes in the high-pressure turbine, the shoes having wiped, due to dirt and foreign matter in the oil, which had not been filtered out. Spare thrust shoes were quickly fitted and the vessel proceeded.

The real trouble came later, when water in some way became mixed with the fuel oil supply to the boilers and caused the fires under the boilers to go out. Thereupon followed a strenuous time ascertaining the source of the water leak into the fuel oil and attempting to get up steam again. The troubles were aggravated about this time by a fire which broke out in the fireroom. This, however, was quickly controlled and put out before any particular damage had been done. The ship, being unable to make headway during this time, anchored, and radio messages were sent out for assistance. The steamship *Panama* stood by and towed the vessel to Ambrose Light, where she was taken in charge by tugs.

The source of the trouble with the fuel oil is unknown, and opinions regarding it vary considerably. The ship itself is one of a standard type, of which a number are in commission, and none of which has ever had trouble of this nature before. The troubles with the *William Henry Webb* were not due to the engines or the boilers, and outside of the wiping of the high-pressure turbine thrust bearing shoes it is stated that the main turbines and gears had given perfect satisfaction.

Questions and Answers for Marine Engineers

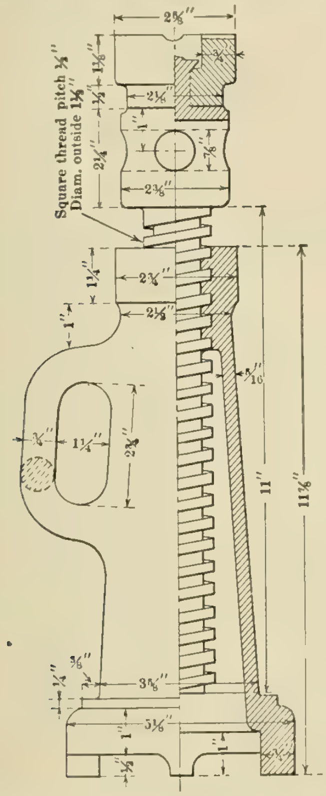
Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Design of Jack Screw and Pillow Block

Q. (1033).—I enclose sketch of a screw jack and would like to know how I could get a table of measurements of two screw jacks of different diameter and pitch; also measurements for pillow blocks for 2-inch and 5-inch shafts. If there are any books on the subject, please let me know. J. S.

A. (1033).—For a description of the proper method of designing jack screws, I would refer you to "Machine Design, Hoists, Derricks and Cranes," by Hess and published by Lippincott Company (1912, page 193), from which some of the matter below is taken.



Sketch of Screw Jack, Showing Dimensions

The screw is subjected to a combined stress, namely, compression and shearing, which can be calculated by the following formula:

$$f = \tfrac{3}{8} f_c + \tfrac{5}{8} \sqrt{f_c^2 + 4 f_s^2}$$

The pressure on the projected area of the thread should be limited to 1,000 pounds per square inch for a brass nut and 700 pounds per square inch for cast iron. Below is given a table of the principal dimensions of several jack screws, the last two columns being from the catalog of Cameron & Barkley Company:

Diameter of Screw, Inches	Height of Jack Closed, Inches	Rise of Screw, Inches	Capacity, Tons
1¼	4	1½	10
1½	6¾	2½	12
1¾	8	3¼	16
2¼	16	9	24

It would appear that the jack screw shown in your sketch was for lighter service than indicated by the corresponding size in your table. In criticism of the former jack screw it is only fair to say that the thickness of the base appears too thin for cast iron, namely, 5/16 inch. Twice that value would appear more reasonable to the writer. In some cases the nut is of wrought steel and bears in part against a steel band shrunk on the upper portion of the cast iron base, serving thereby better to support the latter. In the design shown in the sketch the screw works in the threaded part of the base, which appears to be of cast iron. The diameter of the screw will usually determine the capacity of the jack. The pitch of the screw can be made that for standard square thread.

Since it is not stated what service the pillow blocks (which you wish dimensions of) are called upon to perform, it would perhaps be best to refer you to books on machine design which give proportions of bearings (based on diameter of shaft) with a description of their adaptability to particular service; therefore, see Hess' "Machine Design," Spooner's "Machine Design, Construction and Drawing," Marks' "Mechanical Engineer's Handbook."

Scaling Batten

Q. (1037).—What is the best method of scaling a wooden ship or, in other words, to lay out a scaling batten. E. E. E.

A. (1037).—If by "scaling batten" you refer to the batten used in laying off the width of the various planks, you will find a very good detailed account of laying out the planking, including lifting a spiling, in "A Practical Course in Wooden Boat and Shipbuilding," by Van Gaasbeek, page 78, published by F. J. Drake & Company, Chicago.

Packing Material

Q. (1038).—What is the best material to use as packing (in the form of grommets) under the washers placed under the bolt heads of a joint like the main steam line, where flanged and bolted to the boiler mountings for permanency and tightness? The following have been used:

1. White lead on asbestos wicking.
2. White lead on cotton (lamp) wicking.
3. Strands of ordinary steam valve packing.
4. A small quantity of magnesite, which has worked well in the past.

Is it advisable and according to best practice to use such grommets under bolt heads and washers for such joints? K. W. W.

A. (1038).—The joint of the main steam pipe or stop valve to the boiler nozzle should be tight enough so that the bolts would not require washers and grommets. I have found that magnesite has worked very well on joints of this character. Should a joint start blowing around a bolt, a temporary repair can be made by either of the combinations you suggest, the latter being perhaps preferable; either of the first three would require following up or tightening from time to time.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

AMERICAN SHIPBUILDERS FORM AN ORGANIZATION

Publicity To Be Relied Upon To Foster Maritime Interests—No Lobby Planned—Permanent Merchant Marine the Object

The committee of American Shipbuilders, appointed at a meeting in this city last March, through its chairman, J. W. Powell, vice-president of the Bethlehem Shipbuilding Corporation, Ltd., has given out the following statement:

"Shipbuilders of the United States, including representatives of Atlantic, Pacific, gulf and lake yards, have formed an organization for the purpose of making secure the future of the American merchant marine.

"This movement has the authority of a representative meeting of shipbuilding interests held in New York in March. The committee to-day announces its membershiip and plan of action.

"The committee of American Shipbuilders will conduct no lobby. It will set forth its views mainly by the use of newspaper advertising space. The origin and responsibility for anything it may issue will be clearly stated. It will derive its funds from subscriptions by shipyards based on the average number of employes. The committee's records of its activites and expenditures will be open at all times to every one interested.

"There is evidence on all sides that the American people of all sections and political creeds unite in the belief that an American merchant marine is a necessity, both from the viewpoint of national safety and economic welfare. This belief is deeply rooted in history, in our own experience, and was only emphasized anew when the world war found the United States lacking in the means of transporting either its troops or its products.

"With the greatest foreign trade, the longest seaboard, the largest resources of shipbuilding materials, and the traditions of a nation which had once dominated in the world's sea carriage, the United States shipping had before the war sunk to a point where only 9 per cent of our trade was carried in American ships. Periodically there was discussion of means to end this humiliating situation, but no offensive measures were taken to correct it.

"The need now is to decide what shall be the future of the great commercial fleet built by the Government at a cost of $3,000,000,000. The fate of the shipbuilding industry created during the war; the shipping legislation pending in congress and the demand of the entire country that the United States shall not sink back into a position of inferiority on the seas, are among the reasons why it is believed that a decision as to our shipping policy must be taken.

"It is not believed that a wise decision can be made as to the sale of United States owned ships until measures have been taken which will make it possible to operate these ships profitably. Lacking such measures our fleet will soon pass to foreign ownership or disuse.

"The disadvantages under which American shipping labors and which resulted in the decay of our merchant marine before the war still exist.

"The principal disadvantage is the higher cost of American shipbuilding and operation. It is not possible or desirable to reduce the standards of American wages and living, either in our yards or on our ships. Other measures must therefore be adopted.

'The committee of American shipbuilders will set forth the facts of the situation as it sees them, confident that Congress will take such steps as may be necessary, not merely to protect the shipbuilding industry, but, for the good of the country as a whole, to place the existing and future American merchant marine upon a safe and permanent basis."

The committee is composed of J. W. Powell, vice-president Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa., chairman; H. B. Taylor, vice-president William Cramp & Sons Ship and Engine Building Company, Philadelphia; H. A. Evans, president Baltimore Dry Dock & Shipbuilding Company, Baltimore; A. C. Pessano, chairman Great Lakes Engineering Works, Detroit; J. W. Mason, president Western Pipe and Steel Company, San Francisco; J. F. Duthie, president J. F. Duthie & Co., Seattle; Henry C. Hunter, secretary, 30 Church street, New York.

FIVE TANKERS BOUGHT

Frankel Brothers in Alliance With Oil Concern

The Universal Transportation Company, Inc., and Frankel Brothers, 26 Beaver street, New York, have purchased a substantial interest in the United States-Mexican Oil Corporation, which is said to own more than 50,000 acres of oil lands in the United States and Mexico, with a number of producing wells, and more being drilled.

The oil corporation has just purchased five tank steamers, built by the Terry Shipbuilding Company, of Savannah, at a price said to be $225 a ton, and is negotiating for more vessels of the same class. One of the vessels is to be delivered right away and the others at intervals of six weeks. The carrying capacity of the five will be 1,500,000 barrels.

The company has been operating chartered vessels in the execution of a coal contract with delivery at Marseilles and doing a general cargo business in other trades. These having been completed it is now proposed to enter the oil trade.

Duthie Building Big Towing Vessels

Keels have been laid at the J. F. Duthie & Company shipbuilding plant, Seattle, Wash., for two 2,650-ton steel ships, ordered by James Griffith & Sons. With 1,000 men at work it is expected they will be ready for launching by June 1. One vessel was ordered for the Coastwise Steamship & Barge Company, one of the Griffith subsidiaries, and will be used in coast trade. The other will be sent to England to establish a barge towing service in the coal trade from Wales to northern France. Both vessels will be equipped with powerful towing machinery.

Old Dominion Steamers for Auction in England

The four steamers of the Old Dominion Steamship Company are to be put in the hands of an English auction house, it is learned. They are the *Madison*, 3,734 gross tons, built in 1911; *Jefferson*, 3,723 gross tons; *Hamilton*, 3,723 gross tons, and *Jamestown*, 2,898 gross tons. The *Jefferson* and *Hamilton* were built in 1899. The *Madison, Jefferson* and *Hamilton* have accommodations for 150 first-class and 300 steerage passengers. The *Jamestown*, built in 1894, has accommodations for 100 first class passengers and 175 in the steerage.

CONTRACT FOR TEN TANKERS GOES TO SEATTLE BUILDERS

David Rodgers Will Keep Former Skinner & Eddy No. 2 Yard Busy—Ten More Ships Likely When Present Contract Is Completed

Statements that David Rodgers, of Seattle, whose new company recently purchased the No. 2 Skinner & Eddy plant from the Emergency Fleet Corporation, has enough work in sight to keep the plant going indefinitely, have been inspired by the announcement just made that the American Fuel Oil & Transportation Company, 111 Broadway, New York, has awarded a contract for the construction of a fleet of ten 10,000 deadweight ton tank steamers to the new company. Keels for the first five will be laid promptly, and it is intended to speed up production. Details as to size and cost have not been given out.

There are five modern ways in the No. 2 Skinner & Eddy plant, as it is known to the shipbuilding world, and the yard has a record for speed construction. It has completed its contract for the Emergency Fleet Corporation and has just been turned over to the new owners. Upon the completion of the first group of ten ships it is said that there is a likelihood of an additional block of ten tankers being placed.

The yard covers 17 acres and its ways are large enough for ships of 10,500 deadweight tons. Other facilities were acquired when the plant was purchased from the government at a cost of more than $3,000,000.

It was reported that the deal was financed here by the Irving National Bank, Woolworth Building.

PLENTY OF WORK IN SIGHT

New York Shipbuilding Company Makes Favorable Report

The New York Shipbuilding Company, which has under construction sixteen of the new 855 feet passenger liners for the Shipping Board, had $94,000,000 in ship production under way on December 31, according to the annual report for 1919, just made public. In addition to the Shipping Board order, the company is engaged upon work on twenty torpedo-boat destroyers and two battleships—the *Colorado* and *Washington*. The keel for the battle cruiser *Saratoga* will be laid this summer.

The growth of the plant was shown by the statement that the working force numbered at the end of 1919, 17,500. It was only 12,000 at the end of 1918 and 4,500 in December, 1916. Of this number 3,500 are employed in the South Yard, the construction of which was arranged by the Emergency Fleet Corporation. The plant, which consists of four large building ways, with appurtenant shops and power plant, has been taken over by the company on a profit sharing basis, it was announced.

In addition to the work being done for the Government the company is building four oil tankers for American interests and two for the company's account. President Marvin A. Neeland stated that the corporation had orders in hand sufficient to keep it in operation well into 1921.

Two Ships Made Into One

Admiral Sir Reginald Bacon has revealed a naval secret of the war concerning two British destroyers of the Tribal class. One was the *Zulu* and the other the *Nubian*. They were seriously damaged in the bow and stern, respectively, by mines. Instead of regarding them as losses, shipbuilders took them in hand, and the sound ends were joined together and a new ship turned out. The names of the original vessels were combined in naming the new one *Zubian*.

TO BUILD $500,000 YACHT

Great Lakes Engineering Works Gets Dodge Contract

The contract for the construction of a 257-foot steam yacht for Horace E. Dodge, of Dodge Brothers, the Detroit automobile manufacturers, has been awarded to the Great Lakes Engineering Works, of Detroit, Mich. It is unstood that the boat will cost about $500,000.

The boat was designed by Henry J. Gielow, of 52 Broadway, New York, who will have supervision of its construction. The hull is to be of stee' 257 feet 8 inches in length, with beam of 35.5 feet. Driving power will be furnished by two quadruple expansion engines of 1,500 horsepower each, steam for which will be supplied by three Babcock & Wilcox boilers.

May Scrap the St. Louis

The American liner *St. Louis*, after a service of twenty-five years as a trans-Atlantic vessel, has been turned over to the underwriters by the International Mercantile Marine Company, 9 Broadway, New York, to be sold or sent to the scrap heap, as their ship construction experts may deem fit.

The liner, as the *Louisville*, had carried American troops through the submarine and mine zone during the world war, and was just being turned into a passenger liner again when she caught on fire at Fletcher's Dry Dock, Hoboken, on January 9 last, and was practically gutted.

SHIP SALES CONDITIONS

Terms Announced on Which ex-German Ships are Sold

The conditions laid down by the Shipping Board in connection with the purchase of the ex-German passenger ships recently offered for sale by the Board are as follows:

1. That under contract the operator will recondition at his own expense and responsibility.
2. Reconditioning plans and specifications to be approved by the Shipping Board.
3. Route proposed to be approved.
4. Interest of operator in any given passenger service to be at least 30 per cent. of the venture.
5. Management and operation to be unrestricted.
6. Compensation to be deducted from gross income on basis of 5 per cent. of gross receipts less any other agency commissions paid.
7. Value of ships in present condition to be agreed upon.
8. Operator agrees to buy and Shipping Board agrees to sell when legal obstacles are removed.
9. Until legal obstacles are removed and transfer of title made, profit or loss to be divided between Shipping Board and operator in same proportion as their respective interest may appear and for a period of at least five years.
10. No change of flag would be considered.

Launched at Midnight

A novel event in the history of shipbuilding at Thomaston, Me., was the launching at midnight recently of the schooner *Lloyd W. Berry*, built by Charles A. Morse & Son for Roger Griswold and Captain Harold Peters of Boston. The schooner measures 69 feet over all, is rigged as a fisherman, but will be used in general trade, possibly in the West Indies, under the command of Captain Peters. She cost about $6,000 and hails from Bangor.

To Buy Large Freighters

The General Steamship Company, a new Seattle, Wash., organization, has its service to South America well under way, a steamer having just reached por with a cargo from ports south of the equator.

Announcement is made that the company is preparing to buy a number of large freight steamers.

Inspectors Wanted

The U. S. Civil Service Commission announces open competitive examinations to be held May 5 and 6, June 9 and 10, for local and assistant inspector of boilers and for local and assistant inspector of hulls in the Steamboat Inspection Service. Application blanks may be obtained from the local secretary of the U. S. Civil Service Board at the post offices of the principal cities.

FOX SYNDICATE BUYS MORE EX-GERMAN SHIPS

Purchases For Consolidated Maritime Lines Aggregate About $15,000,000—Vessels All Disposed Of By Shipping Board

Following up their previous purchase of seven of the ex-German vessels held by the Shipping Board, Victor S. Fox & Company, Inc., of 47 Broadway, and their associates, bought from the Shipping Board on Saturday, April 10, vessels aggregating 50,000 additional tons, for the Consolidated Maritime Lines, recently incorporated with a capital of $10,000,000. The additional steamers are the *Eastern Queen*, 9,062; *Jeannette Skinner*, 8,860; *Eastport*, 6,820; *Castlewood*, 4,050; *Liberty Land*, 7,800; *Coosa*, 2,025, and *Armenia*, 7,550 deadweight tons. The *Coosa* is an ex-German and the *Armenia* an ex-Austrian.

According to an officer of Victor S. Fox & Company, the ships purchased from the Shipping Board for account of the Consolidated Maritime Lines now totals fourteen. The following seven were purchased two weeks ago: *Isonomia*, 6,020; *Arapahoe*, 300; *Tonawanda*, 2,847; *Chillicothe*, 3,500; *Moshulu*, 4,950, and *Muscota*, 3,750 deadweight tons.

Of the steamers purchased, two, the *Eastern Queen* and the *Westport*, were built in Japanese yards.

Commenting on the transaction the official of Victor S. Fox & Company said that the cost of the fleet will be about $15,000,000. He said the enterprise has contracts to carry large quantities of grain and coal to Mediterranean and Black Sea ports, and eventually general cargo services from United States ports to the Mediterranean and Black Sea and South America and the West Indies will be established.

Victor S. Fox, who, with A. G. Lampke, of Lampke & Stein, general counsel for Victor S. Fox & Company, conducted the negotiations with the Shipping Board, issued a statement to the effect that he was making arrangements for the taking of further Board tonnage. He expressed confidence that the Board's policy of encouraging those who invest in its vessels would result in the assignment of a large amount of Shipping Board tonnage to the Consolidated Maritime Lines for management. His estimate on this point was 200,000 tons.

The ships already acquired were bought on the new charter purchase plan. Initial payments made were said to have amounted to more than $1,000,000.

WASHINGTON, April 11.—At an auction held at the Shipping Board offices on Saturday the seven remaining ex-German cargo vessels were sold. The Board has now disposed of its entire list of 34 former enemy vessels. The only ex-German vessels left which might be classed as freighters are a small ship of 600 deadweight tons and a wooden sailing vessel.

RECONDITIONING SHIPS

Navy Doing the Work on Recent Contracts

The *Powhatan*, formerly the ex-German liner *Hamburg*, which was disabled when 350 miles from Halifax, has been turned over to the Shipping Board by the War Department, and will be put into commercial service as soon as she is reconditioned. The vessel is being surveyed preliminary to being sent to the Brooklyn Navy Yard.

The *Powhatan* has a gross register of 10,531 tons, and had accommodations for 1,382 passengers. She is 500 feet long and has a speed of 16 knots.

When the ex-German ships were put up for sale the *Powhatan* was assigned to the Baltic service, but did not attract any bidders. It is reported that some American interests are seeking to obtain her for the Mediterranean trades.

There are several ex-German and former Austrian ships now under repair and reconditioning. The *Huron*, *Aeolus*, *George Washington*, *Martha Washington* and *Agamemnon* are being refitted. The *Susquehanna* and *Callao* are in commercial services. It is stated that the government is in a quandary as to what it will do with the *De Kalb*, which was badly damaged by fire, as it is felt that the cost of converting her into a first-class passenger liner will be excessive.

The Army retains control of the *Mount Vernon*, *America*, *Mercury*, *Pocahontas*, *Princess Matoika*, *President Grant* and a few other vessels which would be valuable as passenger carriers if they were reconditioned.

The most recent contracts have been made with the Navy on a time and material basis, private companies not having had an opportunity to bid.

England Buying Ship Plates in Canada

An order has been placed for ship plates in Canada by the British firm of Armstrong, Whitworth & Co., Ltd., of the Elswick Works, Newcastle-on-Tyne. The original quantity wanted by the English concern was 20,000 tons, but it was found impossible to supply the entire amount from the Sydney, N. S., mill of the Dominion Steel Corporation, on account of the pressure of other business, notably the plates being supplied under contract for the Canadian Government, which amounts to 50,000 tons per year, and will be increased to 75,000 tons. The mill at Sydney has a capacity of 100,000 tons of plates per year.

Advantages of Electric Soldering Iron

The electric soldering iron, when compared to the type heated in a gas flame or fuel-burning muffle, exhibits improvements, both in operation and convenience which should make its adoption in shops where soldering is carried on a matter of serious consideration.

The ordinary type iron is, as a rule, anything but economical, either from the standpoint of time or of material. It requires continual reheating, since it chills very quickly from radiation, and nearly every time it is reheated the tinning is destroyed. The electric iron, on the other hand, once heated remains hot as long as it is needed, but does not become hot enough to oxidize the tinning or the copper.

A Special Feature of the Electric Soldering Irons Is Its Flexible Handle

Due to the fact that it does lose heat rapidly, the average soldering iron is made with a very large, heavy copper element, usually none too securely fastened to an iron rod having a light, wooden handle. As a consequence, the iron is hard to use because of its lack of balance. For working in corners or narrow places a skilled operator is required to manipulate it with any degree of success.

To overcome this awkwardness, the General Electric Company, Schenectady, N. Y., has developed an electric iron having a heavy spiral wire handle, which allows a certain degree of flexibility, while giving the iron a good balance and a firm connection to the copper.

Other features of the gas-heated iron make it more or less undesirable, and among these is the fire risk. Gas flames are subject to blowing back and exploding.

The average fuel-burning muffle is at best smoky, inconvenient and far from economical. There is always danger of the iron rolling off a bench if laid down for a minute and starting a fire.

The electric iron can be quickly attached to any lighting circuit and a constant heat is assured. The spiral handle is expanded into a guard ring where it joins the tip, so that the heated part of the iron is raised when the iron is not in use. This feature removes the fire hazard.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIP CONTRACTS

Freighters, Seattle, Wash.—J. F. Duthie & Company will build two small freighters of about 1,600 deadweight tons each for their own account.

Converting Steamers, Boston, Mass.—The steamers Governor Cobb and North Land, of the Eastern Steamship Lines, will be converted from coal to oil burners.

Barges, Rondout, N. Y.—Bernard J. Donovan has a contract with New York parties to build four barges to be delivered by June 1. Each barge will be 110 feet long and 33 feet wide.

Ferryboat, Boston, Mass.—Fay, Spofford & Thorndike are to design the new ferryboat, for which $400,000 of the budget of the city of Boston is to be spent to relieve the ferry service to East Boston.

Steamers, New Orleans, La.—Keels have been laid by the Doullut & Williams Shipbuilding Company for the fifth, sixth and seventh hull of the 9,600-ton ships contracted for by the Shipping Board.

Tankers, Everett, Wash.—The Norway-Pacific Shipbuilding Company has closed a contract with the Norwegian Tankers Company, Ltd., of Christiania, for five 10,600-ton tank steamers, totaling $11,000,000.

Reconditioning Ex-German Ships.—A permanent injunction has been made against the sale of the ex-German passenger vessels by the United States Shipping Board. The board has decided to proceed with reconditioning these ships.

Steamers, Wilmington, N. C.—Upon the completion of three 9,600-ton steamers contracted for by the Shipping Board, the George A. Fuller Company will begin the construction of steel ships on its own account at the Carolina yards.

Tankers, Oakland, Cal.—Contract has been placed by the Shell Company of San Francisco with the Union Construction Company for one 10,600 deadweight tons tanker, and by the Standard Oil Company of California with the same builder for an oil carrier of about 2,000 tons.

Conversion of Destroyers, New London, Conn.—The turbine-driven American torpedo boat destroyers Reid, Flusser, Preston and Lawson are to be converted into Diesel-driven passenger vessels and private pleasure crafts by the New London Ship and Engine Company.

Steam Lumber Carrier, Hoquiam, Wash.—Contract for the construction of a steam lumber carrier for the Hart-Wood Lumber Company has been closed with the Matthews Shipbuilding Company. The vessel will be built at the Peninsula Shipbuilding Company's plant, and will be named the Quinault.

Steel Steamers, Pensacola, Fla.—The Pensacola Shipbuilding Company has contract for the construction of six 9,000-ton steel steamships for English buyers. The contract calls for vessels 402 feet in length, 36 feet breadth and 24 feet depth, to be fitted with Scotch boilers and reciprocating engines.

Freighters, Newark, N. J.—The Submarine Boat Corporation will build for sale twenty freighters of 9,000 deadweight tonnage, with a speed of 12 knots and a draft of about 25 feet; propulsion will be either by steam or Diesel engines, and probably some will be equipped with internal combustion engines.

Passenger and Cargo Ship, San Francisco.—It is reported that the Matson Navigation Company, if it fails to secure a vessel from the Shipping Board, or in the market, plans to let contract for building a vessel equipped with deck hatch and side port openings for Pacific trade. The company at present has two large freight carriers under construction.

Equipping Ships, Coos Bay, Oregon.—The Pacific Marine Ironworks has contracts for equipping three Oregon built ships. Two of the vessels are at the yards of Kruse & Banks, on Coos Bay. Contracts for boilers, engines and machinery run between $140,000 and $150,000 on each ship. The third contract is for the vessel to be built for the Hartwood Lumber Company.

Tanker, Oakland, Cal.—A contract to build a bulk oil carrier of 16,340 deadweight tons capacity has been awarded to the Moore Shipbuilding Company by the Southern Pacific Company, Pier 49, North River, New York. The vessel will be 535 feet over all in length, 71 feet beam, 39 feet depth, and 23,000 tons displacement, and will carry 125,000 barrels of crude oil.

Towing Steamers, Seattle, Wash.—Keels have been laid at the J. F. Duthie & Company shipbuilding plant for two 2,650-ton steel towing ships, ordered by James Griffith & Sons for launching June 1. One vessel will be for the Coastwise Steamship & Barge Company, one of the Griffith subsidiaries, and the other will establish a barge towing service in the coal trade from Wales to Northern France.

Completing Hulls, Portland, Oregon.—It is proposed to purchase a number of unfinished hulls from the Shipping Board, which will be converted into six-masted schooners. The money has been raised by popular subscription and the craft will be used to carry timber products of the Columbia River district. Cost of each craft estimated at $150,000. Capacity, 2,000,000 feet of lumber.

Tankers, Seattle, Wash.—The American Fuel Oil & Transportation Company, 111 Broadway, New York, has awarded a contract for the construction of a fleet of ten 10,000 deadweight ton tank steamers to the new David Rodgers Company, which has bought the Skinner & Eddy No. 2 yard. Keels for the first five will be laid promptly, and it is intended to speed up production. Details as to size and cost have not been given out.

Tankers, Seattle, Wash.—The Skinner & Eddy Shipbuilding Company will build a 13,500-ton bulk oil carrier for Knute & Knutsen, representing Norwegian interests. Contract for engines, which will be 3,600 horsepower, not awarded; contract for three boilers, 15 feet 9 inches in diameter and 12 feet 2 inches long, awarded to Commercial Boiler Works of Seattle. Other contracts are expected, according to D. E. Skinner, president of the company.

Converting Steamer, South Freeport, Me.—At the yard of the South Freeport Shipbuilding Company one of the three Ferris-type steamers contracted for by the Shipping Board, which was about 40 percent completed when work was stopped, has been bought by the builders, who are making it o er into a four-masted schooner. It will be ready for launching by mid-summer, at which time the keel for a four-masted schooner of about 1,200 tons will be laid.

Reconditioning the Leviathan.—Specifications for the reconditioning of the Leviathan will be sent to prospective bidders. The Shipping Board intends to open the bids on May 1. Plans provide for making of the ship into one of the finest modern passenger vessels, estimated cost of reconditioning being around $6,000,000. The board seeks a lump-sum offer, and has decided against a cost plus contract. Specifications will be sent to any responsible company asking for them. The navy also will bid.

Tankers, Mobile, Ala.—According to Birmingham, Ala., advices, the Mobile Shipbuilding Company has an offer from British interests for the building of twenty large steel tankers, and will accept the contract if the Birmingham Steel Corporation, which is the fabricating plant of the shipbuilding company, secures the material. It is announced that approximately $10,000,000 is to be spent toward increasing the output of steel for use in the Mobile company's yard. Plans are being drawn for the vessels in the British contract.

Tankers, Shooters Island, N. Y.—On April 19 keels were laid for two of the four 8,400-ton oil tankers which the Standard Shipbuilding Corporation is building for the Eagle Oil Transport Company, Ltd. ,of London. The berths were decorated with American and English flags, and while the first rivets were being driven the Standard Shipyard Band played appropriate American and British airs. These ships are being built on the Isherwood system, will be 427 feet long, 53 feet 1 inch beam and 24 feet depth, and will have a speed of eleven knots.

Yacht, Detroit, Mich.—Contract for the construction of a 257-foot steam yacht for Horace E. Dodge, of Dodge Brothers, Detroit automobile manufacturers, has been awarded to the Great Lakes Engineering Works, of Detroit, Mich. It is understood that the boat will cost about $500,000. It was designed by Henry J. Gielow, of 52 Broadway, New York. It is to be of steel, 257 feet 8 inches in length, with beam of 35.5 feet. Two quadruple expansion engines of 1,500 horsepower each, with steam supplied by three Babcock & Wilcox boilers will be the propelling power.

Schooners, Maine Ports.—Contracts have been made for building a number of four-masted schooners in ports of Maine, majority ranging from 1,000 to 1,300 tons. The East Coast Ship Company, Boothbay, will build one, the Atlantic Coast Company, of the same town, two, both for Crowell & Thurlow, Boston; Russell Shipbuilding Company, Portland, two four-masters; Cumberland Shipbuilding Company, Portland, two; and the Bath district, an indefinite number, but including two five-masters; four-masters are to be built at Rockland, Thomaston and Harrington, while at Machias two, or possibly three, vessels of the same type will be built this year.

SHIP YARDS AND DRYDOCKS

Groton Iron Works, Groton, Conn.—Having made satisfactory settlements with their creditors, the Morse interests are again in full charge of the plant.

Plate Shop, Newburgh, N. Y.—The Newburgh Shipyards Company, Newburgh, N. Y., has plans for building a plate shop fitted with overhead cranes and modern machinery, and estimated to cost about $350,000.

Shipyard Purchased, Port Jefferson, N. Y.—The Bayles Shipyard was sold by the Shipping Board to the New York Harbor and Dry Dock Company for $2,025,000. Previous sale to A. P. Allen canceled, as terms were not complied with.

Marine Railway Company, St. Andrews, Fla.—Capitalized at $50,000, the St. Andrews Marine Railway Company has organized and applied for patents. The principal business is to be construction of ships, repairs to vessels, and the like, and to construct, maintain and operate a marine railway. W. D. Miller, West Bay, is president; W. E. Tiller, St. Andrews, secretary and treasurer; W. S. Moates, St. Andrews, vice-president.

PORT IMPROVEMENTS

Quays, Baltimore, Md.—The quay system has been suggested in the development of the harbor under the $50,000,000 port loan provisions.

Bulkhead, Etc., Hammond, Oregon.—The town has voted $50,000 bonds to build bulkhead and reclamation work along the Columbia River.

Swan Island Basin, Portland, Oregon.—Unanimous approval of the Swan Island basin improvement project has been made by the Commission of Public Works.

Terminals, Wharves, Etc., Jacksonville, Fla.—City Commission plans to construct wharves, railroad terminal facilities, warehouses; estimated cost, $2,000,000.

Dredging and Excavating, Buffalo, N. Y.—United States Engineer Office, 540 Federal Building, rejected the only bid received March 17 for dredging and rock excavating in Black Rock Channel.

Improve Ferry Service, East Boston, Mass.—A bill allowing the city to borrow $1,000,000 outside the debt limit for improvements of the East Boston ferry service was passed, to be engrossed April 9.

Dredging, Buffalo, N Y.—G. H. Norton, City Engineer, let contract for dredging in Buffalo inner harbor to the Great Lakes Dredging and Dock Company, Morgan Building, $.0335 per cubic foot.

Lock and Esplanade, Florence, Ala.—United States Engineer Office rejected the only bid received, January 2, for building a lock and esplanade at Widows' Bar, Tennessee River, near Bridgeport.

Bulkhead, Quincy, Mass.—Application to build a bulkhead and fill Bent's Creek has been made by the Fore River plant of the Bethlehem Shipbuilding Corporation, Ltd., to the State Department of Public Works.

Dredging, Detroit, Mich.—Sealed proposals will be received at the United States Engineer Office until 11 A. M., May 5, 1920, for dredging in St. Clair River at Port Huron, Mich. Further information on application.

Piers, Seattle, Wash.—The Union Oil Company of California plans to extend Pier 18 a distance of 250 feet, also tear down temporary dock and build pier 450 feet long and 50 feet wide. Cost between $175,000 and $200,000.

Jetties, Portland, Oregon.—The removal of jetties in Williamette Slough and opening the slough to steam navigation has been recommended by the Government Engineer in charge of channel work in the river below Portland, Oregon.

Dredging, Tacoma, Wash.—The dredging of the Tacoma waterway to a depth of 30 feet up to Eleventh street bridge will be recommended to the Government by Lieut.-Col. J. A. Woodruff, United States Engineer Office, Tacoma district.

Improving Wharf, New Orleans, La.—The Dock Board will make extensive improvements on the Poydras street wharf, including the building of sheds, a mezzanine floor, etc.; estimated cost for additions and improvements about $559,000.

Dredging, Philadelphia, Pa.—The United States Engineer Office, 815 Witherspoon Building, let contract for dredging in the Delaware River, Philadelphia Harbor, to the American Dredging Company, Mariner & Merchant Building, $519,639.

Dredging and Rock Removal, Hudson River.—United States Engineer Office, 39 Whitehall street, has let contract for dredging and rock removal in Hudson River to the Great Lakes Dredging and Dock Company, 17 Battery Place, New York, $656,978.

Pile Wharf, Dredging, Boston, Mass.—Plans have ben filed by Simpson's Patent Dry Dock Company, of East Boston, with the State Department of Public Works, Division of Waterways and Public Lands, and application made for a license to build a pile wharf and to dredge in Boston Harbor, East Boston.

License Needed at Terminal, Charleston, S. C.—A War Department license will be required by vessels wishing to utilize port terminal facilities when space is available. No dead storage will be accepted, and live storage will be permitted not exceeding forty days.

Breakwater, Corpus Christi, Texas.—City soon receives bids for building rubble mound breakwater in Corpus Christi Bay, involving 100,000 cubic yards stone rip rap. C. J. Howard, city engineer; R. J. Cummins, 203 Stewart Building, Houston, Texas, consulting engineer.

Repairing Breakwater and Placing Riprap, Cleveland, O.—Bids will be received until May 20, 1920, by the United States Engineer Office, Federal Building, for repairing rubble mound east breakwater and placing riprap in front of west breakwater at Cleveland harbor.

Dredging, San Francisco, Cal.—The United States Engineer Office, Fair Building, let contract for dredging part of point from Des Rios Island and vicinity near mouth of Sacramento River, Third District, to San Francisco Bridge Company, 1005 Nevada Bank Building, $388,200.

Pier, Portland, Oregon.—City let contract for building Pier 5, involving 84,000 linear feet wood pile driving, 70,000 linear feet sheet timber piling in place, 25,000 pounds dock iron and 12,000 cubic yards riprap in place, to A. Guthrie & Company, Sherlock Building, $37,865.

Dredging, Boston, Mass.—Commissioner of the Department of Public Works received bids April 2, for dredging 110 cubic yards of rock ledge from entrance to dry dock basin, from W. E. Barber, Boston, $11,900; G. T. Rendle Company, Boston and Albany Railroad bridge, $12,600; Bay State Dredging Company, 62 Condor street, $29,900.

Dredging, New York.—Murray Hulburt, Commissioner of Docks, Pier A, North River, rejected bids received March 30 for furnishing labor and material for dredging in Manhattan, Queens and Richmond boroughs. About $100,000. Let contracts for dredging in North River to F. E. Jones, 17 Battery Place, $32,780; East River, to F. S. Ross, $40,640.

Piers, Stapleton, S. I., N. Y.—Murray Hulburt, Commissioner of Docks, Pier A, North River, New York, received bids April 6 for building, (a) Pier 12, (b) Pier 13, from Smith, Hauser & MacIsaacs, 81 E. 41st street, (a and b) $2,288,089; Snare & Triest, 8 W. 40th street, (b) $1,272,596; G. B. Stearin, 90 West street, (b) $328,315; contractors all of New York.

Lengthening Wharves, Portland, Maine.—United States Engineers contemplate extensive improvements, including the lengthening of wharves along the whole waterfront in connection with the new State pier, involving an expenditure of several million dollars, in addition to the cost of the pier, which is set at $2,000,000. The necessary consent of the War Department it is expected will be given.

Dry Dock, Camden, N. J.—The erection of a mammoth drydock at an estimated cost of $3,000,000 was assured at a recent meeting of the City Council, at which it was decided to sell to Fraser, Brace & Company the two little-used streets needed to carry out the plan. Fraser, Brace & Company have purchased the dry dock from the Government and another one will probably also be bought. In the same yard will be a score of machine shops and warehouses.

Pier, New York.—Murray Hulburt, Commissioner of Docks, Pier A, North River, New York, received bids March 29 for altering pier at Fifth street, East River, etc., from Snare & Triest, 233 Broadway, $120,500, Lustig & Weil, 103 Park avenue, $124,000; associated contractors, 17 West 42d street, $131,490; water supply and plumbing from Egan Company, Inc., 217 West 13th street, $5,888; W. Young Plumbing Company, 32 Old Broadway, $6,278; Altman Plumbing Company, 802 Second avenue, $7,350.

Phosphate Terminal Plant, Fernandina, Fla.—Construction is progressing upon the $500,000 phosphate terminal plant of the Florida Terminal Company. The buildings will be of steel sheathed with corrugated galvanized iron, being on pilings, with foundations and tunnels of concrete. The crushing and drying plant will have an hourly capacity of 60 tons, while the ship-loading equipment will have an hourly capacity of 500 tons, and the storage capacity is to be 25,000 tons. Charles E. Waddell, Asheville, N. C., is consulting engineer; with him is associated F. J. Dreyer, also of Asheville.

New York Harbor.—Port committees have been appointed by the Governors of New York and New Jersey, and legislative measures authorizing an agreement between them introduced. The plan provides for a district to be known as the Port of New York, which in New York State will include practically all of the city of Greater New York and extend up the Hudson River beyond Yonkers and into Westchester County on the East River side. The port authority will have power to finance proposed projects and develop the port district in terminal transportation and other facilities. The New Jersey section of the district will include the west bank of the Hudson, the Newark Bay district and the Kill Van Kull waterfronts. Murray Hulburt, Pier A, North River, New York, Commissioner of Docks.

SHIPPING DEVELOPMENTS

To Buy Large Freighters.—The General Steamship Company, of Seattle, Wash., is preparng to buy a number of large freight steamers for its South American service.

Fruit Steamers, Baltimore, Md.—The Baltimore & Jamaica Trading Company has placed two large fruit steamers, the Fort Morgan and Fort Gaines, on the Baltimore-Jamaica route.

Boston-Bordeaux Service.—The France & Canada Steamship Company is to have a Boston-Bordeaux service, the Shipping Board steamer Lake Frugality having been allocated for this purpose.

Coastwise Steamers.—The Carolina and East Coast Navigation Company, of New Bern, N. C., a new concern, with a capital stock of $1,000,000, plans to operate a line of coastwise steamers and barges.

Buying Tankers, Savannah, Ga.—The Terry Shipbuilding Corporation is reported negotiating to buy from the Shipping Board five steel tankers which it is completing for the Emergency Fleet Corporation. Two have been launched and three are on the ways.

Mobile-Rotterdam Service.—The Isthmian Line, operated by Norton, Lilly & Company, 26 Beaver street, New York, has begun regular communication between Mobile, Ala., Rotterdam, Holland, and ports in the Far East, with vessels built at the Chickasaw yards, Mobile.

Coastwise Service to Be Resumed.—Sailings about every three weeks giving an express service betwen New York and San Pedro, the port of Los Angeles, Cal., thence to San Francisco, are planned by the Luckenbach Steamship Company, 44 Whitehall street, New York.

Sale of Steamers, San Francisco, Cal.—The steamer Bee has been bought by the F. M. Stark Steamship Company from Fred Lindermann, and the Hornet from C. C. Mengel & Company by the S. E. Slade Lumber Company. The Bee sold for $125,000, and the Hornet on private terms.

Pacific-New York Line.—The Osaka Shosen Kaisha, of Osaka, Japan, is to operate a trans-Pacific line without subsidy from Singapore to New York by way of San Francisco and the Panama Canal. A regular vessel on the new line is now being built at the Osaka Ironworks.

Increasing Fleet, Chester, Pa.—The Sun Oil Company has added two new tankers to its fleet of eight ships; they are 430 feet long, 59 feet beam, 33 feet 3 inches deep and 10,300 deadweight tons each. The company also plans spending more than $2,000,000 in enlarging its refining plant at Marcus Hook.

Seeking Passenger Steamer, San Francisco, Cal.—E. D. Tenney, president of the Matson Navigation Company, is on his way to San Francisco from Honolulu to secure a passenger vessel for Pacific service from the Shipping Board. It is understood that a representative of the company in the East has been unable to get a satisfactory vessel.

Enlargement of West Coast Service, Boston, Mass.—Plans have been completed by the New England Maritime Corporation to enlarge its service between Boston, Philadelphia, Los Angeles, San Francisco and Seattle. Application has been made for a change in the name of the concern, which is to be known as the North Atlantic and Western Steamship Company.

Increase of Capital, Pawtucket, R. I.—The Blackstone Valley Transportation Company, of Pawtucket, R. I., has increased its capital from $250,000 to $500,000, and will handle freight shipments between Pawtucket and Philadelphia by way of the Harbor Launch Corporation Line between New York and Philadelphia. New steamers and the leasing of larger port facilities in New York are part of the development plan.

Tankers Bought, New York.—The Universal Transportation Company, Inc., Frankel Brothers, 20 Beaver street, New York, and the United States-Mexican Oil Corporation have bought five tank steamers built by the Terry Shipbuilding Company, Savannah, at a price said to be $225 per ton and are negotiating for more vessels of the same class. The sales are for prompt delivery, and the steamers will carry an aggregate of 1,500,000 barrels of oil.

Inland Marine Corporation, Syracuse, N. Y.—The Inland Marine Corporation has been formed to operate a fleet of fifty-seven cargo boats and ten steamers along the Atlantic seaboard, the New York State barge canal and other inland waterways and the Great Lakes. The New York terminal is at Pier 5, East River. The corporation is a consolidation of the Shippers' Navigation Company, of Syracuse, and the Long Island Barge Company, with a capitalization of 20,000 shares, no par value.

To Enter Mediterranean Service.—The Old Dominion Line, Pier 25, North River, New York, is preparing to enter the Mediterranean and Black Sea service with a fleet that finally will comprise twenty modern steamships, including six passenger carriers. The line will retain its piers at Beach street, North River, extending them to suit the larger ships it will acquire. Four steamers of the company, the Madison, Jefferson, Hamilton and Jamestown, are to be put in the hands of an English house for sale at auction.

Shipping Board Sales, Washington, D. C.—Five Lake type ships were sold by the Shipping Board to the Oriental Navigation Company, 17 Battery Place, New York, for approximately $2,400,000; a steel cargo ship, 7,825 tons, to the Pioneer Steamship Company, 15 Wall street, New York, $1,682,375; a cargo vessel 2,500 tons, Tropical Fruit Company, 61 Broadway, New York, $275,000; steamer, 2,875 tons, Baltimore and Carolina Steamship Company, $474,806; seagoing tug, Cuban-Atlantic Transport Company, $225,000; steamer, 4,500 tons, Medrigal & Company, Manila, P. I., $237,500; seven harbor tugs, J. W. Sullivan & Company, 827 East Ninth street, New York, $80,000 each; cargo steamer, 7,467 tons, to the American Merchant Mariners' Company, $217 per ton, less depreciation; steel cargo ship of Submarine Boat type, 5,350 tons, to Manuel Vicento Ribernio, Lisbon, Portugal, $200 per ton. Six steel sailing ships and one cargo steamer, 6,020 tons, to Victor S. Fox & Company, 47 Broadway, New York, for approximately $1,900,000, standard charter purchase plan, payments to extend over three years. Additional sales include seven ex-German and Austrian cargo ships aggregating about 50,000 tons, to Victor S. Fox & Company, Inc., and their associates, for the Consolidated Maritime Lines, recently incorporated, with a capital of $10,000,000. The purchases of the Fox syndicate aggregate about $15,000,000, and initial payments made amounted to more than $1,000,000. The board has now disposed of its entire list of thirty-four former enemy vessels, and has on hand as freighters only a small ship of 600 tons and a wooden sailing vessel.

GOVERNMENT WORK

Refrigerating Plant, Guam, P. I.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to build a refrigerating plant. About $40,000.

Submarine Base, San Pedro, Cal.—The United States Senate Committee on Naval Affairs has reinstated the item from the naval estimates appropriating $500,000 for submarine base, which has been outlined. The House Committee cut out the item, but Southern California interests had it reinstated before the bill goes to conference.

Electrical Equipment, Guam, P. I.—Spec. 4169. The Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to furnish and deliver 200-kilowatt turbo-generator f. o. b. Mare Island, shipped by Government Naval Station here, 10-kilowatt exciters, 775-kva. transformers, large and several small switchboards. About $32,000.

Electrical Equipment, South Charleston, W. Va.—Electrical equipment, Spec. 4146, Bureau of Yards and Docks, Navy Department, Washington, D. C., soon receives bids for furnishing and installing switchboards, oil switches and barriers, busses and connections, storage battery generator set, transformers, disconnecting motor starters and other electrical equipment furnished by Government; also making necessary connections for complete indoor sub-station ready for operation at Naval Ordnance Plant here. About $195,000. $10 deposit required for plans and specifications.

FOREIGN MARITIME MATTERS

Mines in the Kattegat.—It is reported that the Kattegat, between Tistlarna and Paternester Skaeran, is full of floating mines, probably torn loose by recent gales.

Amalgamation, Halifax.—It is reported that an amalgamation of the steel companies, Canada Steamship and the Halifax Graving Dock, now operated by the Halifax Shipyards, is to be effected.

New Shipbuilding Company, Vancouver, B. C.—A new shipbuilding company with a capitalization of $1,000,000 has taken over the British Columbia Marine Ways of Vancouver and will make extensive alterations and improvements.

Shipbuilding Plant, Three Rivers, Quebec, Can.—The National Shipbuilding Corporation has let wood piling contract and erecting 95 by 340 feet shipbuilding plant on River Road to the Raymond Concrete Pile Company, 10 Catherine street, Montreal; $100,000.

Turbine Steamers, Birkenhead, Eng.—Cammell, Laird & Company, Ltd., Birkenhead, Eng., have booked an order for two geared turbine steamers for the Osaka Shosen Kaisha, of Nagasaki. They are to displace 15,000 tons and will have a sea speed of 13 knots.

Harbor Headwalls, Toronto, Canada.—The Toronto Harbor Commission let contracts for building harbor headwalls from York to Bay streets to Weddell & Saunders, McArthur Construction Company, 36 Toronto street. About $1,500,000. Work involves 125,000 cubic feet reinforced concrete.

Shipyard Merger, Newcastle-on-Tyne.—The Newcastle Shipbuilding Company, Ltd., has taken over the business of the Huntley Shipbuilding and Repairing Company, Ltd., at Hebburn. The new yard of the Newcastle Company has a river frontage of 1,600 feet and a depth of nearly 1,000 feet.

Subsidy, Iceland.—A proposal for the State contribution of 30,000 kroner for the establishment of a steamship service between Gothenburg, Sweden, and Iceland has been introduced in the Iceland Parliament. The contribution is, however, conditional on the Swedish Government granting a similar sum.

Port Improvements, Dominican Republic.—Vice-Consul George A. Makinson, at San Domingo, reports that the Dominical Republic has completed a number of wharves,

bridges and other improvement work in the last two years, and that a large amount of similar work is being planned for the immediate future.

Marine Finance Corporation, London.—The Merchant Marine Finance Corporation of London has been formed for the purpose exclusively of financing shipbuilding. Directors include Sir Frederick Hall, chairman; Sir Edward Mountain, managing director, and Sir John Esplen, director of Furness, Withy & Company.

Steamship Merger, London, England.—G. Instone & Company, Ltd., of London and Cardiff, Wales, managing owners for the Instone Transport & Trading Company and the Woolston Steamship Company, Ltd., has purchased the Woolston Steamship Company, owner of a fleet of 20,000 tons afloat and several vessels building. Price is nearly £1,000,000.

Motorship, Sweden.—The Sound yard at Landskrone in Sweden, which is Danish owned, is to build an 8,000-ton motorship to be fitted with Burmeister & Wain Diesel engines. It is interesting to note that this shipyard has hitherto specialized in the construction of the modern type of turbine steamer with reduction gear, and the change is therefore significant.

Steamships for West Coast.—It is reported that two steel freighters have been ordered from British builders for the South American-Pacific Line by Seattle headquarters of the company. One is of 7,000 deadweight tons, and will be built by Robert Thompson Company, Ltd., of Glasgow, and the other, of 6,700 tons, will come from the Clyde Ship & Engine Company, Glasgow.

Electric Power at Leith Docks, Scotland.—The Dock Commissioners of Leith will install at the Albert dock a steam turbine-driven generator of 1,500 kilowatts capacity to take the place of the present gas-driven engines; cost, about £40,000. The reconstruction of the wall of the outer harbor near the Prince of Wales dock has been authorized at a cost of £19,000.

Dock Improvements, Liverpool.—The Mersey Docks and Harbor Board is to provide electrical elevators, conveyors and other equipment at the grain warehouses at a cost of £35,000. The entrance to the Alfred dock, Birkenhead, is to have a new lock 600 feet long and 80 feet wide, with three pairs of gates; the outer locks will be closed. The improvement is to cost £680,000.

Shipping Deal, Liverpool.—It is reported that T. and J. Harrison, of Liverpool and London, have acquired the fleet of Prentice, Service and Henderson, of Glasgow, and Scrutton, Sons & Company, London. Of the thirteen vessels purchased, all especially adapted for the West Indian trade, seven were taken over from the Glasgow firm, with an aggregate tonnage of 36,000 tons.

Port Improvement, Bari, Italy.—The Italian Ministry of Public Works has allotted 84,125,000 lire for port construction at Bari. It is intended to make the city the most important harbor on the Adriatic. An administrative board has been organized and 16,000,000 lire set aside to develop Porto Maurizio, on the Gulf of Genoa, to serve the maritime interests of the Piedmont region and generally of Northwest Italy.

Ship Repairing, Jarrow-on-Tyne.—The Mercantile Dry Dock Company, Ltd., has bought the eastern portion of the Chayters estate for the extension of its business. The property covers about 100 acres and adjoins the Mercantile Company's present property, with an extensive front to the river. It is regarded as po sible for the new owners to create the largest rep iring shipping establishment in the United Kingdom.

Shipyard Extension, Greenock, Scotland.—Plans for the eftension of the shipbuilding industry at Greenock, which are backed mainly by Harland & Wolff, have passed the British Parliament. The work will require about three years to complete, and will cost between £2,000,000 and £3,000,000. The Parish Church and church yard wi'l be removed, the church erected on another site, west harbor is to be filled up, the west and a number of streets widened.

Port Improvements, Vigo, Spain.—Propositions for the construction of an extensive port at Vigo have been approved by the Spanish Ministry. This work is to be done to facilitate the constantly-increasing commerce of the port. A royal decree has been signed authorizing the issue of a 100,000,000 peseta loan for the building of docks, which, it is reported, will be constructed by a New York firm. It is rumored that American financiers have agreed to subscribe a considerable portion of the loan.

Bunker Coal, England.—Bunker coal at the port of London is selling at 155 shillings per ton. Coal for British industrial works is selling at the controlled price of 40 shillings per ton, and equivalent quality bunker coal at 140 shillings per ton. Since last May the price of bunkers has risen by 100 shillings per ton, while ordinary cargo freight rates are practically unchanged. There is a mo ement in progress to advance the outward freight rates from the United Kingdom by 50 percent if bunker prices cannot be lowered.

Auxiliary Sailing Ship, Leith, Scotland.—Before the war a 5,000-ton auxiliary sailing ship was under construction at the yard of Messrs. Ramage & Ferguson, Leith, for the East Asiatic Company, Copenhagen, Denmark, in which Diesel engines of the Burmeister & Wain type were to be installed. This vessel was taken over during the war by the British Admiralty. A similar ship is being built by Messrs. Ramage & Ferguson. One of the main reasons for building this craft is to provide a means of practical training of engineers for the East Asiatic Company.

New Shipbuilding Berths, Tyne, England.—The Tyne Commissioners have sanctioned construction of three shipbuilding berths, 128 feet, 210 feet and 285 feet long respectively, by the Newcastle Shipbuilding Company at Hebburn; also for a ferro-concrete quay at the Renwick and Gradwish yard at Hebburn; for the renewal of the dock gates and walls of the No. 1 dry dock of John Readhead & Sons, Ltd., of South Shields, and temporary extensions to three building berths and the laying out of two additional building berths at the Bill Quay yard of Wood, Skinner & Company.

Ship Construction, Bristol Channel, England.—A private firm, understood to be Vickers, Ltd., is reported to have secured a lease for thirty years for the Pembroke Dock Yard from the British Admiralty. It is planned to make the dock yard a merchant ship construction plant. It is reported that the Llanelly Patent Ship, adjoining the Carmarthenshire Dock has been secured by a company for shipbuilding purposes. The National shipbuilding yard at Chepstow, on the Severn estuary, has been sold to a company which proposes to build ships and utilize the tidal range of more than forty feet to produce electricity for commercial use.

Motorships, Glasgow.—The British India Steam Navigation Company, of London, is ha ing two motorships built by Barclay, Curle & Company, of Glasgow, and one by Robert Duncan & Company. They are 450 feet long, 58 feet beam, 35 feet deep, with a draft of 27 feet 11 inches when loaded to their capacity of 10,670 tons. Each vessel will have two 8-cylinder engines, built by the North British Diesel Engine Works, of 2,300 indicated horsepower each. The cylinders are 26½ inches diameter, 47-inch stroke, with a speed of 96 revolutions per minute. One ship will have 13½ knots' speed and the other two 12½ knots, the difference being accounted for by the fact that in the first cεse the engines have independent compressors, and in the second the compressors are on the main engine.

Large Motorship, Holland.—The Dampskib Storford, A. S., of Stavanger, Norway, has placed an order for a motorship of 9,500 deadweight capacity with J. & K. Smit, of Kinderijk, Holland. She will be 439 feet 8 inches over all, 57 feet 1 inch beam, 27 feet draft. Twin-screw Werkspoor machinery will be installed, comprising two 2,140 indicated horsepower 6-cylinder engines, with cylinders 670 mm. bore and 1,200 mm. stroke, running at 110 revolutions per minute. These are the highest powered engines of the Werkspoor four-cycle type that have yet been built, and three other sets are under construction for single-screw ships, the San Andres and the Sardinia, for the Otto Thoresen Line of Christiania, and a new vessel for Winge & Company, also of Christiania.

British South Africa.—Extensive harbor improvements have been approved for African ports which will probably cause a demand for modern harbor equipment at Table Bay. Purchase of a crane of 50 to 100 tons capacity is being considered; a 633-foot quay, with a low-water depth of 38 feet and carrying a large warehouse, is being constructed, and the reclamation of a area of about 140 acres will increase docking facilities. A graving dock 1,140 feet long, 110 feet wide, with 35 feet depth for the sill at low water, is planned for Cape Town. Several piers on the north side of the harbor, with warehouse accommodation and extension of the present jetty, are planned for Algoa Bay. At East London, rock in the Narrows is being removed, and partial removal of the east training wall is projected. A graving dock is in process of construction at Congella, and plans call for the extension of the wharf to a low-tide depth of 40 feet. Other wharves planned will provide 1,150 feet of berthing space for vessels drawing up to 38 feet 6 inches, and efficient coaling appliances will be installed, a quay and fuel oil tanks are also to be erected.

Breakwaters, Wharves, Etc., Ontario, Canada.—Dominion Government, Ottawa, plans to making the following improvements in the Province of Nova Scotia: Repairs to breakwater, Devil's Island, cost $13,000; West Chezzetcooke, $15,000; reconstruct breakwater, North Ingonish, $11,000; harbor improvements, Inverness, $12,000; wharf, Sydney, $100,000. Province of Quebec, wharves—Anse aux Gascons, $36,000; North Temiskaming, $13,000; Grosse Isle, Quarantine Station, $50,000; Pointe Pizeau, Sillery, $13,000; St. Ann de Beaupre, $30,000; St. Famille, $17,000; St. Francis Sud $33,000; St. Jean d'Orleans, $31,000; St. Laurent, Island of Orleans, $21,000; St. Michel de Bellechasse, $36,000; Sorel, $10,400; piers—Grande Riviere, $12,900, Pointe Shea, Amherst, $10,000; harbor improvements, Rimouskie, $13,000. Province of Ontario, breakwaters—Collingwood, $50,000; Port Colborne, $66,500; wharves—Kagawong, $12,000; Oshawa, $15000; piers, Rondeau $17,000; harbor improvements, Port Stanley, $19,000. Province of British Columbia, improving lower Fraser River, $25,000; wharves—Kincolith, $11,000; Powell River, $11,000. Province of Prince Edward Island, boat harbor, North Lake, $27,000; breakwater, Souris, $40,000. Province of New Brunswick, repairing breakwaters and piers, Cape Bald, $10,000; repairing breakwater—Petit Rocher, $15,000; Shippigan Gully, $12,000, reconstructing breakwaters and repairing pier, Quaco (St. Martin's), $22,000. E. Lafleur, care of Department of Public Works, Ottawa, engineer.

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Fig. 1.—25-Horsepower Alternating Current Squirrel Cage Motors Driving 48-Inch Propeller-Shaft Lathes in Pennsylvania Shipyard

Electric Motors for Shipyard Machinery

Motors and Control Best Suited for Various Classes of Machinery—Circumstances Governing Choice of Motor—Individual vs. Group Drive

BY WILLIAM HARRISON, JAMES GOLDSBOROUGH AND WILLIAM H. EASTON*

THE electric motor is now universally regarded as the best form of drive for shipyard machinery, and its use for every possible power purpose is a matter of standard practice in the shipbuilding and repairing industry throughout the world.

But electric motor drive is satisfactory under one condition only: the motor and its controller must be perfectly suited to the driven machine; and since shipyard machines vary widely in their speed and power requirements, and since there are numerous types of motors, each with its own special electrical and mechanical characteristics, and each with several different methods of control, the selection of the proper electrical equipment for a given machine is not always an easy matter.

However, the field of application of each type of motor and control is quite definite, and if the limits of these fields are clearly recognized, the problem of motor selection becomes greatly simplified. It is, therefore, the purpose of this article to discuss the types of motors and controllers that can be used with each class of shipyard machinery and to indicate what equipment is best under given circumstances.

Direct Current Motors vs. Alternating Current Motors

The first point to be settled in laying out the electrical equipment of a shipyard is whether direct current or alternating current motors are to be used. Both have their advantages and both have their limitations. These must be carefully considered before a decision is made.

The chief feature of the direct current motor is that (for reasons explained later on) it is superior to any

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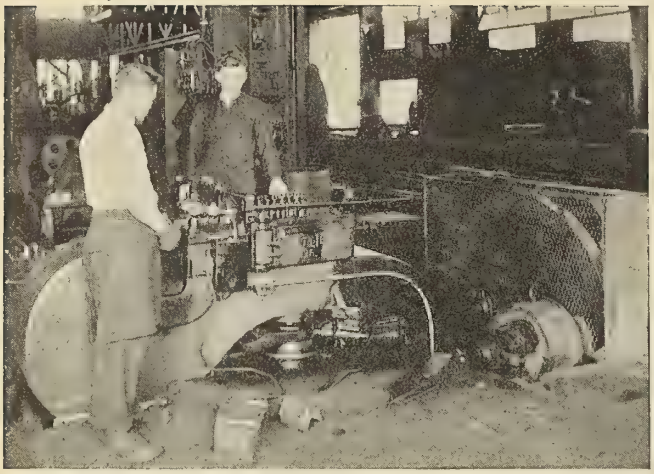

Fig. 2.—Direct Current Motor, With Push Button Control, Driving Horizontal Punch at Cramp's Shipyard

other form of power for driving adjustable speed machine tools, such as lathes, drills, etc. So great indeed is this superiority that no other power should be considered for use in the average machine shop. Direct current is also the only power that can be used for operating electric yard locomotives and for charging the batteries of the small electric trucks and tractors that are becoming increasingly popular in all industrial plants.

For driving practically all the other shipyard machines, however, alternating current motors are quite as satisfactory as direct current motors, and are generally preferred because they are simpler in construction and require somewhat less attention. Hence, they are used wherever possible.

But the chief feature of alternating current is that, because its voltage can be raised and lowered at will, it is the only form of power that can be economically transmitted long distances. Hence its use is practically compulsory when the transmission lines exceed about 1,000 feet in length.

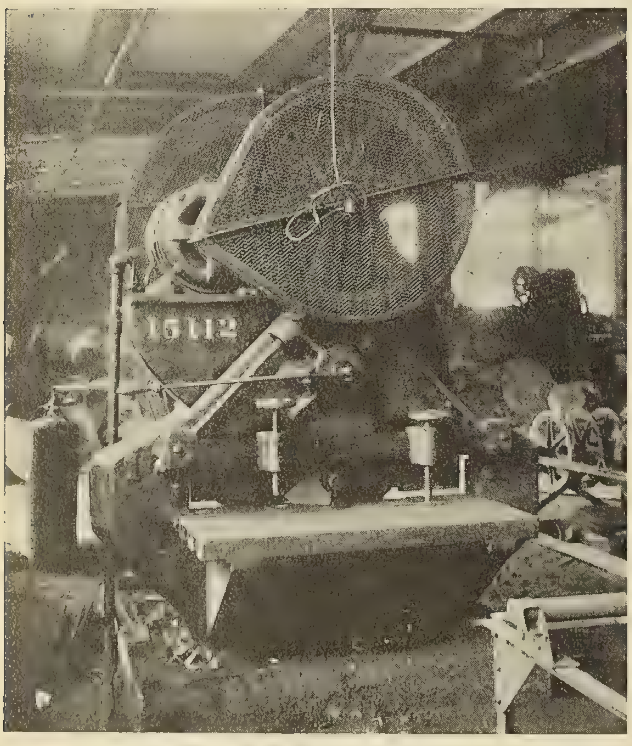

Fig. 3.—10-Horsepower Alternating Current Squirrel Cage Motor Geared to Angle Shears at Pennsylvania Shipyard

To sum up, small yards generating their own power should use direct current throughout. Large yards, on the other hand, should generate alternating current, use this power for practically everything except for the machine shop and for transportation, and, for these special purposes, generate a supplementary supply of direct current by means of rotary converters or motor generator sets (preferably the former, because they are more compact and efficient).

An increasing number of yards are buying power from central stations, instead of generating it themselves, because central station power is, in general, more economical, reliable and convenient than that produced in private plants. Central station power is almost invariably supplied in the form of alternating current, so that when it is used a supplementary supply of direct current is necessary.

If a shipyard having central station current available should for any reason generate its own power, its power should be the same as that of the central station, so as to be able to use the latter for breakdown service.

Individual vs. Group Drive

There are two methods of driving machines by means of motors:

1. Individual drive—a motor on each machine.
2. Group drive—several machines driven through line shafting and belts by a single motor.

Individual drive is, however, the only method used for practically all shipyard machinery, since group drive is only advantageous for compact groups of constant speed machines that are all engaged continuously in the same kind of work, and such groups are rare in shipyards. The data in the following text, therefore, apply only to individual drive, except when otherwise stated.

Motors for Adjustable Speed Machine Tools

By adjustable speed machine tools is meant such tools as lathes, drills, milling machines, shapers, planers and others that must be operated at different speeds in order to suit different kinds of stock.

From the standpoint of motor drive the most important requirements of these machines are the following:

1. The speed range must be sufficiently large to suit all ordinary work.
2. A large number of separate speed steps should be available.
3. The speed on each step must be constant regardless of the load.

As to the first requirement, a lathe, or other machine tool, that operates only at one speed would have a very limited usefulness. Fo rmany of the jobs that might come to it, its speed would be so high that it could not handle them at all, while for others its speed would be so low that its output would be too small to be economical. Consequently, for average machine shop service, where each machine must handle a variety of jobs, machine tools must have a range of speeds.

Secondly, the number of speed steps available on a machine has an important bearing on the amount of work it can turn out. If, for example, the tool has but three speeds—slow, medium and fast—these speeds would suit exactly only a small proportion of the jobs to be done, and most of the work would necessarily have to be run off at too low a speed (the next higher speed being unusable), so that production would suffer. But if the machine has, say, 19 speed steps, practically every job can be run off at its highest permissible speed and the machine can be pushed to its economical limit.

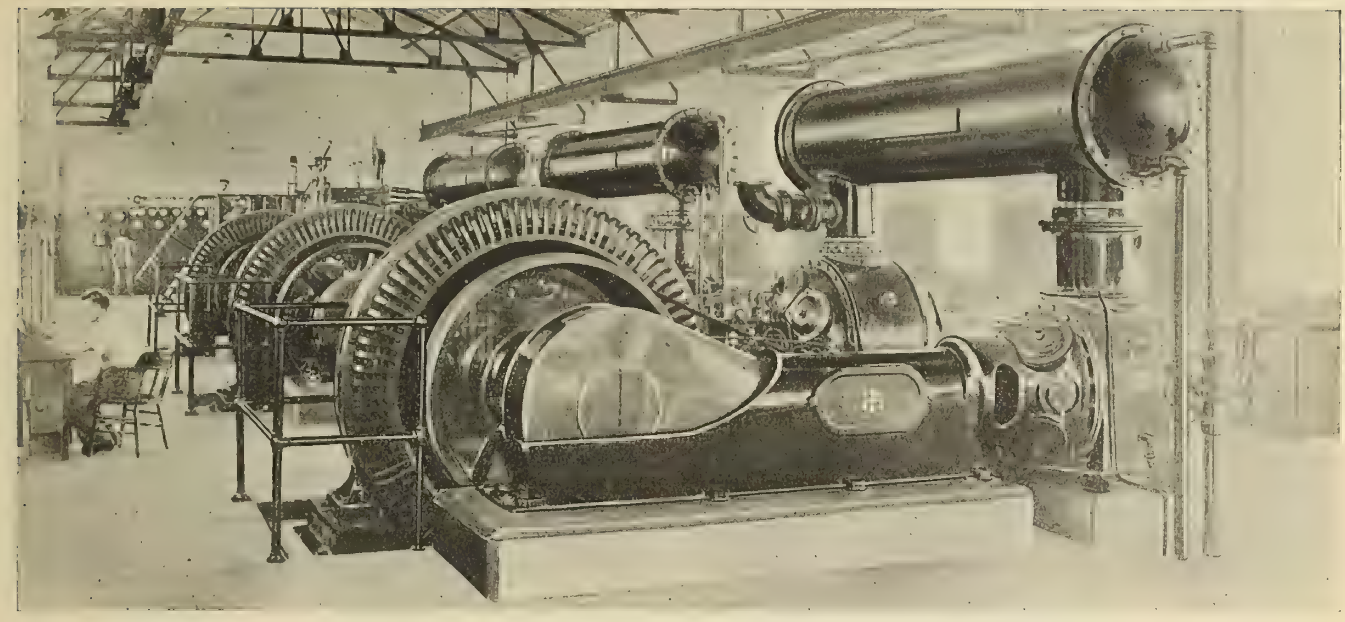

Fig. 4.—A Battery of Air Compressors Driven by Synchronous Motors

Finally, constant speed on each step is essential, since if the machine speeds up when running light and slows down when the cut is started, good workmanship becomes impossible.

Direct Current Motors.—It is because the shunt-wound, direct current motor admirably fulfills all these requirements that it is invariably used, wherever possible, for driving adjustable speed machine tools.

This type of motor can be obtained in sizes and speeds to suit all machine tools, and with windings for operation on all commercial voltages. Standard speed ranges are 1 to 2, 1 to 3, and 1 to 4 (for example, 750 to 1,500 revolutions per minute, 500 to 1,500 revolutions per minute, and 350 to 1,800 revolutions per minute), the last range being wide enough to suit the economical speed range of almost every machine tool. Full horsepower can be obtained on any speed.

These motors can be belted to machine tools intended for line shaft drive, but the modern machine tool is specially designed for motor drive, with the motor built into the machine, and the greater output of these machines, because of their properly selected speeds, conveniently located control, and their ability to take maximum cuts with high-speed steel tools, makes their use advisable under almost all circumstances.

Control.—The control of these motors consists of two

Fig. 5.—General View of Joiner Shop in Pennsylvania Shipyard. Each Machine is Driven by an Alternating Current Squirrel Cage Motor

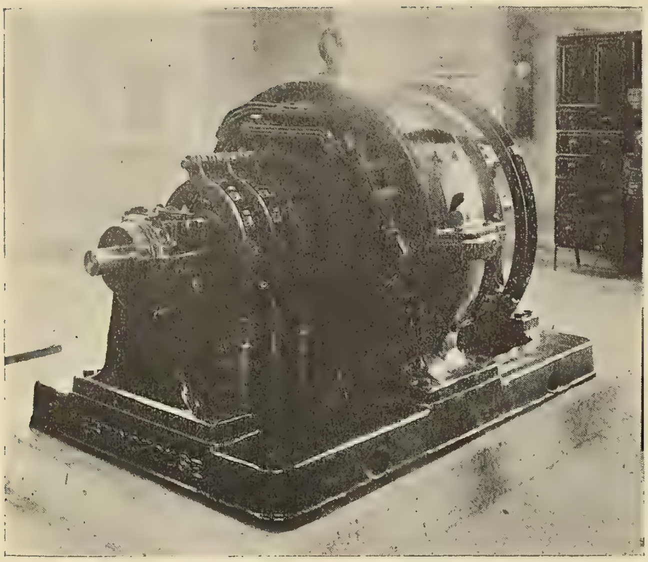

Fig. 6.—500-Kilowatt Rotary Converter for Transforming Alternating Current into Direct Current. New York Shipbuilding Corporation, Camden, N. J.

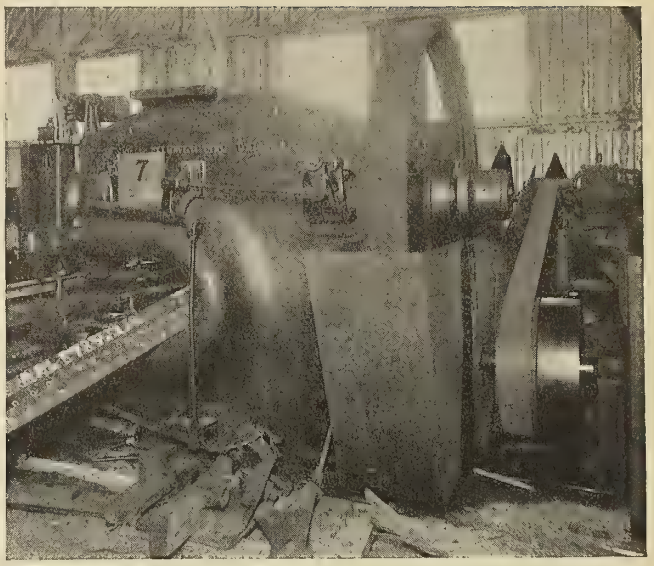

Fig. 8.—Direct Current Motor Belted to Punch. In the Old Shops of the Standard Shipbuilding Company, Shooter's Island, N. Y.

parts, the starting box and the speed regulator. The first, or the starting box, contains resistance connected in series with the motor armature and cut out in a series of steps so that the motor is gradually brought up to speed. If the motor were connected directly across the line without the use of a starter, it would either burn out or unduly stress the tool by starting too abruptly.

The speed regulator consists of resistance which is connected in series with the motor field circuit and is varied by turning a handle. By increasing this resistance the motor speed increases, so that the lowest speed of the motor is its normal speed, i. e., the speed with no resistance in the field circuit.

These two elements can be obtained mounted on the same panel and operated by a single handle, or they can be supplied separate, with the starter mounted near the motor, and the speed regulator on the machine tool convenient to the operator.

Ordinarily, they are both manually operated, but automatic control is becoming more and more widely used. With the automatic controller, the operator merely presses a button to start the machine and another to stop it. When the "start" button is pressed, the starting resistance is automatically cut out by a series of magnetically operated switches which bring the motor up to speed in the shortest time consistent with safety. This method saves a great deal of time, which means increased production, because the operator can control the motor without leaving his position, and without giving thought and attention to the proper operation of the starting box. It also saves dammage to the starting resistance or to the motor, due to operating the starting box too slowly or too rapidly.

Usually, only the starter is automatic, the speed regulator being manually operated; but it is possible also to increase and decrease the speed of the machine by merely pushing buttons, and this is often desirable in the case of large machines.

Protection.—These controllers, as well as those used for the great majority of other motors, should furnish two kinds of automatic protection: (1) low voltage, and (2) overload.

The low-voltage device disconnects the motor from the line in case the power should fail, thus making it necessary to start the motor by means of the starting box when

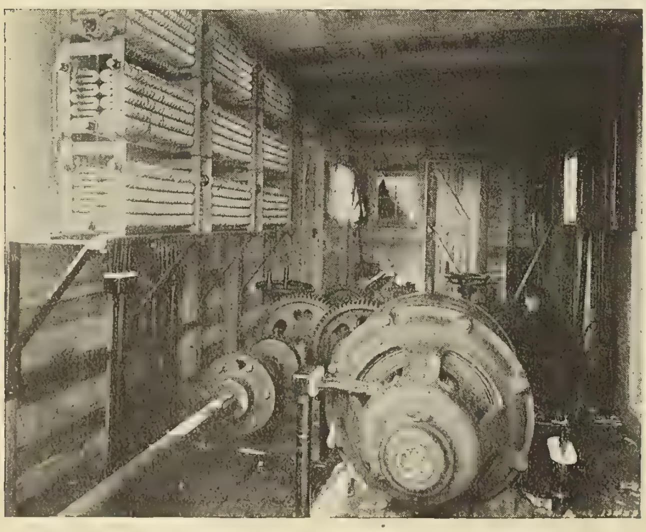

Fig. 7.—125-Horsepower Wound-Rotor Motor Driving 24 Pumps on Vulcan Iron Works Dry Dock

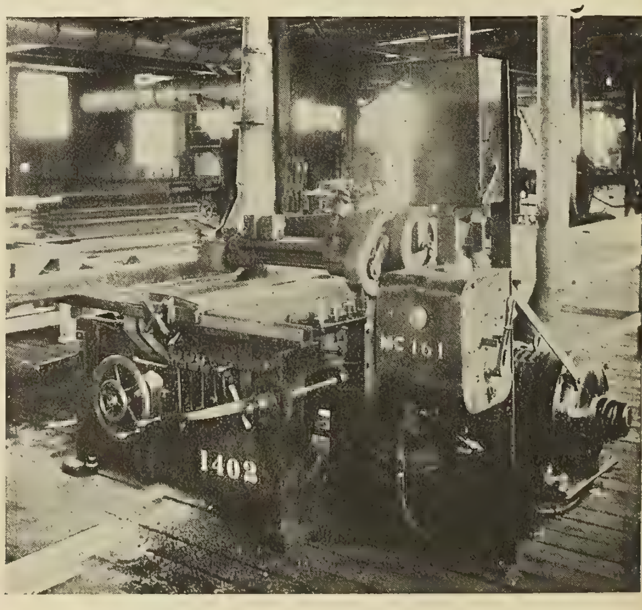

Fig. 9.—15-Horsepower Alternating Current Squirrel Cage Motor Driving Planer in a Shipyard

the power returns. Otherwise the motor might burn out on the return of the current, or a machine might start up unexpectedly and injure someone. The device usually consists of a magnet that is energized by the line current and holds the handle of the starter in the "on" position against the force of a spring. When the current fails, the magnet releases its hold and the handle automatically returns to the "off" position.

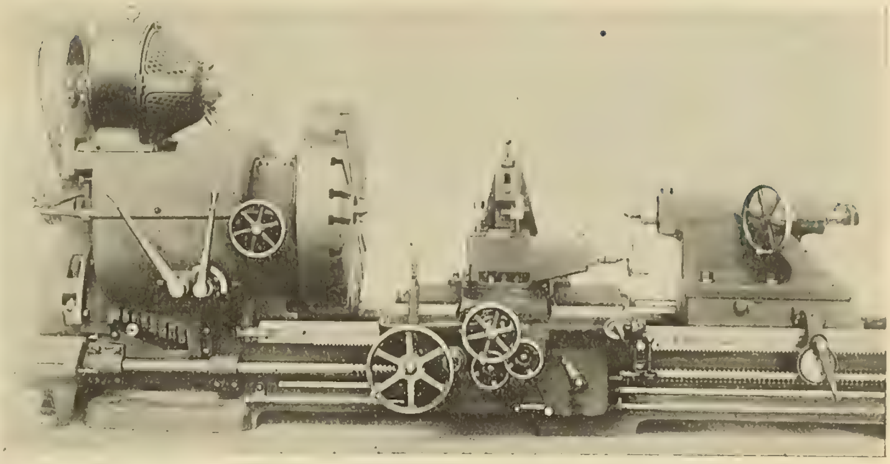

Fig. 11.—Modern Heavy Duty Lathe Especially Designed for Direct Current Motor Drive

Overload protection is essential to prevent the motor being overloaded and taking too great an amount of current, which would, of course, destroy it. It usually consists of a fuse or a circuit breaker which opens the circuit at a definite current valve and must be replaced or reset by hand.

Motors operating pumps and other machinery which are intended for continuous operation without constant attendance are frequently equipped with protection that is automatically reset when the trouble is eliminated, thus making a visit after a failure of power unnecessary.

Direct Current Planer Motors.—A special direct current motor has been designed for driving planers. It is directly connected to the machine and reverses at each stroke, so that the complication of belts and pulleys necessary with the older type of drive is eliminated. The cutting speed and the return speed can be adjusted independently, and as a wide variety of speeds is available, maximum production can be obtained from the planer.

The motor is especially designed throughout, as the service is very severe. The control is of the automatic type, with a manually operated speed regulator; and in order to facilitate setting up the work, a push button switch attached to a flexible cable is supplied, by means of which the operator can start, stop, "inch" or reverse the platen from any point around the machine.

Alternating Current Motors.—Though there are variable-speed alternating current motors, they are not suitable for operating machine tools, because their speeds (especially the reduced speeds) vary with the load. Consequently when alternating current only is available, machine tools should be driven by constant speed motors and the speed changes produced by mechanical means.

As compared with the use of direct current motors, this method of drive is unsatisfactory because it involves complicated systems of belts, shafting and pulleys, and also provides but a few speeds, so that maximum production cannot be obtained. It is, therefore, employed only in case of necessity, or where machine work is relatively unimportant, or for machines doing only a single restricted class of work.

The alternating current motor used for this drive is of the squirrel cage type, which is the simplest motor made. It consists only of a frame with a set of coils, a very rugged rotating part, and two bearings, and it has no moving electrical contacts and therefore does not spark. It is, however, a strictly one-speed machine.

Squirrel cage motors in sizes of 5 horsepower and less are usually started by being directly connected to the line. For larger motors, auto-starters, which bring the motors gradually up to speeds in two steps, are used.

Punches and Shears

The chief features of this important class of shipbuilding machinery are: (1) the speed is constant, and (2) the load varies almost instantly from zero to maximum, so that a flywheel is needed to assist in the operation of the machine.

Alternating current motors are preferred for the drive of these machines, but direct current motors are also entirely satisfactory. The motor can be either geared or belted to the machine, but recent practice favors gearing because it is positive and does not slip when the load comes on.

Direct Current Motors.—The direct current motor used for this service is the compound wound type. This differs from the shunt wound machine in the construction of the field coils, but the essential difference lies in the fact that its speed varies more widely with the load than does that of the shunt wound motor.

This characteristic of the compound wound motor is of importance in driving punches and shears, because when the load comes on, the motor tends to slow down, thus permitting the flywheel to carry the machine over the peak. This, of course, reduces the speed of the flywheel somewhat, but as soon as the load goes off, the motor speeds up again and restores energy to the flywheel for use at the next stroke. The result of this process is to smooth out the power demand of the machine and eliminate the high peaks that would occur with the use of a strictly constant speed motor.

These motors require only a starter of either the manually operated or the

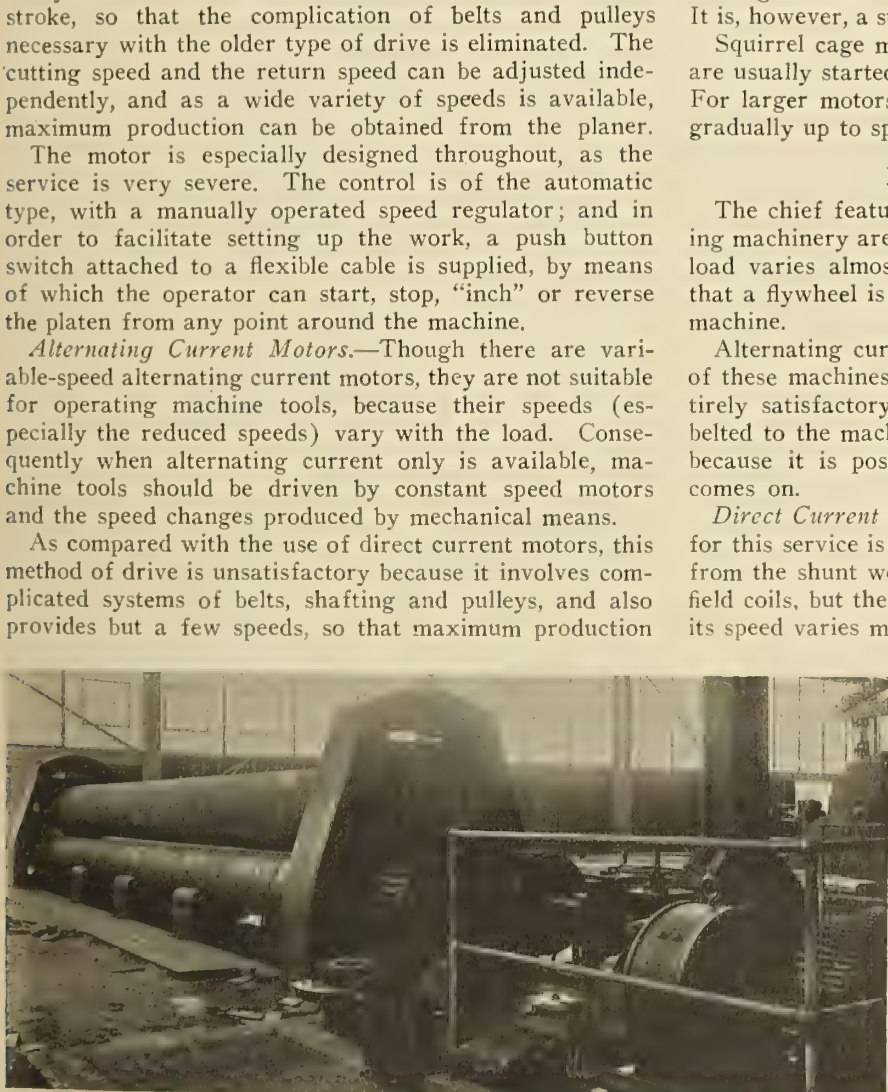

Fig. 10.—100-Horsepower Compound Wound Direct Current Motor Driving Heavy Duty Bending Roll, New York Shipbuilding Corporation, Camden, N. J.

push button automatic type, whichever may be preferred.

Alternating Current Motors.—Though many standard squirrel cage alternating current motors are in use for driving punches and shears, the preferred type of motor for this service is that known as the "high slip" or "high torque" squirrel cage motor. The construction of this motor is the same as that of the standard type, except that the electrical resistance of the rotor circuit is increased by the use of a special alloy in place of copper. This increased resistance causes the motor to slow down under load and thus produces a speed characteristic similar to that of the compound wound direct current motor described above and permits the flywheel to carry the peak loads in a similar way. An auto-starter is the only control device required.

The squirrel cage motor, of either the standard or the high slip type, has, however, a limitation that sometimes prevents its use in large sizes: it draws a very large amount of current from the line in starting. Where a shipyard has its own power plant and the capacity of the generating and transmission system is sufficiently large, this momentary excess demand for current is of no importance, but central stations often prohibit the use of squirrel cage motors larger than a specified size (from 5 to 25 horsepower, depending on conditions).

Under such conditions the continuous-duty wound rotor motor is employed. This motor is similar to the squirrel cage, except that the rotor is so arranged that resistance varied, by means of a drum controller, can be inserted in the rotor circuit. By starting the motor with all the resistance in series and bringing it gradually up to speed by cutting the resistance out step by step (just as with a direct current motor), the rush of current during the starting period is avoided. When operating at full speed, this motor has the same characteristics as a high-slip motor.

Bending and Straightening Rolls

Either direct current or alternating current motors are satisfactory for driving bending and straightening rolls.

Direct Current Motors.—A special type of direct current motor, called the "bending roll" motor, is used for this service. This motor is very heavily compound wound, so that its full load speed is about one-half its no-load speed. Consequently, when the plate enters the rolls the motor speed immediately falls off, thus protecting the motor and the rolls from shock; but when the rolls grip, the load lightens and the speed increases. These motors are supplied with either drum type or automatic starters, arranged for reversing the motor.

Alternating Current Motors.—The alternating current motor used for operating bending and straightening rolls is the wound rotor, "intermittent duty" type, with a reversing drum type controller. The intermittent duty, wound rotor motor closely resembles the continuous duty motor described above, but it is specially designed to develop high power for short intervals and it is not suitable for continuous operation at full rated load.

Wood Working Machinery

Practically all of the machinery in the joiner's shop is of the constant speed type and can be driven by either squirrel cage, alternating current motors or shunt wound, direct current motors. The former are, however, by far the better because they do not spark and their simple construction makes them practically immune from troubles due to the presence of sawdust. Consequently, the squirrel cage motor is always used for driving wood working machinery wherever possible.

It is well to point out, however, that though a squirrel cage motor *can* operate half buried in sawdust, it is bad practice to allow it to do so. It should, of course, be kept clean and be blown out with compressed air at least once a week.

If direct current motors are used, they must in general be totally enclosed to prevent the entrance of sawdust, and the starters must be provided with covers, so that the sparks at the contacts cannot start fires.

Headstock Motors.—Though the turning lathe is generally driven by a constant speed motor, it is an exception to the general rule of wood working machinery, inasmuch as an adjustable speed, direct current motor forms its best drive.

A special form of direct current motor is supplied for this machine. This motor forms the headstock of the lathe, the shaft being threaded to take both a live center and a face plate, and it can be operated over a speed range of from 600 to 3,000 revolutions per minute by means of a controller mounted on a leg of the lathe. This arrangement eliminates belts, greatly simplifies the lathe, provides a wide range of speeds, and permits a considerable increase in production.

Air Compressors

The air compressor is a constant speed machine and can be driven by either a shunt wound, direct current motor or a squirrel cage (or wound rotor), alternating-current motor. Another type of motor—the synchronous—is, however, being favored for large compressors in alternating current plants.

The synchronous motor is quite different from either the squirrel cage or the wound rotor motor, being, in fact, an alternating current generator with certain modifications. Among its advantages are a rigidly constant speed and a high operating efficiency, but the main reason for its use in industrial plants is its ability to "correct the power factor" of the alternating current system.

A full discussion of power factor is not possible here, but, briefly, in a plant where there is a number of squirrel cage and wound rotor motors an adverse condition tends to arise in the power supply, known as "low" power factor. Low power factor causes certain operating troubles that interfere with the efficient operation of the plant, but it is readily corrected by operating a synchronous motor of proper capacity on the line.

A machine to be driven by a synchronous motor must start lightly loaded, run continuously at constant speed, and be of comparatively large size. The air compressor fulfills these requirements, so it is usually selected for synchronous motor drive in a shipyard, though large centrifugal pumps are also often driven in the same manner. The motor is generally of the high-voltage type and operated directly from the main power when central station power is used, thus saving the cost of step-down transformers.

As the synchronous motor requires expert attention, it is generally placed in the power plant. Small compressors located throughout the yard are driven by squirrel cage motors.

Dry Dock Pumps

For operating dry dock pumps, comparatively large amounts of power must ordinarily be transmitted considerable distances, so that alternating current is almost invariably used in this service. There are, it is true, cases where the power house is located close to the dock and the cables are so short that the use of direct current is practicable; but such cases are exceptional.

Floating Docks.—The pumps of floating docks may be driven in two ways:

1. An individual motor on each pump. In this case the motor is usually of the vertical type, and from its location on the working deck drives the pump in the pontoon by means of a long shaft that passes through the superstructure of the dock.

2. One motor drives a group of pumps, usually those in a section of the dock. Motors for this purpose are of the standard horizontal type and drive the pumps by means of a line shaft.

For some docks, variable speed motors are specified, in which case wound rotor motors must be used. For other docks, constant speed motors are preferred, and then squirrel cage motors are generally employed.

On most docks the controller for each motor is located close to the motor, but a much better arrangement is to use automatic controllers, each of which is in turn controlled by a small master switch, and locate all the master switches in a single control station, so that an operator can control instantly the operation of any or all of the pumps.

Graving Docks.—In graving docks the pumps are operated by constant speed motors, usually of the squirrel cage type. The control is generally manually operated, but automatic control is recommended for all motors larger than 100 horsepower.

Cranes and Hoists

Cranes and hoists must be operated over a range of speeds from zero upwards, and the greatest power must be produced at the lowest speed.

Special crane motors are supplied for operation on both direct current and alternating current circuits. The direct current motor is a series wound machine with speed control by means of heavy resistance in the armature circuit and special connections to prevent overspeeding when lowering. The alternating current motor is of the wound rotor, intermittent duty, variable speed type.

The electrical equipment for cranes and hoists is always selected by the manufacturer, so that a detail description of these motors and controllers is unnecessary.

Other Machines

Other machines, besides those mentioned, are used in shipyards, but the proper type of motor for driving them can be readily determined from the data given.

Ship Repair Work at the Panama Canal

The illustration shows three ships dry docked together at Balboa, the Pacific terminus of the Panama Canal. The total length of the three ships is 968 feet. The dry dock is 1,000 feet long by 110 feet wide at the bottom, with a depth of 45 feet over the keel blocks at high tide, and can accordingly accommodate the largest ships in the world.

The ship nearest the reader is the *Lake Fitch,* 262 feet long and of 2,939 gross tons. Her hull was cleaned, repaired and painted, and repairs made to her boilers and main engines, propellers, stern tube, tail shaft, steering gear and rudder, auxiliary machinery, sea valves, and forepeak tank. In the center is the *Lake Garza,* 261 feet long, of 2,482 tons. Work on her included hull repairs, cleaning and painting, repairs to feed and bilge pumps, sea valves, windlass, fire-room ventilator and telegraph. The ship next the entrance is the *San Joaquin,* 445 feet long, of 7,059 tons. Boiler repairs, cleaning and painting and winch repairs were the principal items for this vessel.

On the far side of the dry dock is seen the 50-ton steam crane which travels around the coping of the dock and out on the repair wharf, beyond the shop buildings, in the right middle distance. The large ship at the repair wharf is the 9,000-ton *Cristobal* being overhauled and virtually rebuilt in her interior. The photograph shows about a third of the shops, which employ over 2,000 men. On the extreme left is the coaling plant of the Pacific terminus of the Canal.

Thousand-Foot Graving Dock at Balboa, Showing Three Merchant Vessels Docked Simultaneously for Repairs

Tank Steamer of 12,620 Tons Deadweight

Type of Vessel Building for the Standard Transportation Company at the Fore River Plant of the Bethlehem Shipbuilding Corporation, Ltd.

At the Fore River plant of the Bethlehem Shipbuilding Corporation, Ltd., Quincy, Mass., there are under construction for the Standard Transportation Company, of New York, four single-screw steel tankers of the shelter-deck type built on the longitudinal system of framing with straight stem and elliptical stern. There is a bridge house amidships containing the officers' accommodations, and a deck house aft around the engine and boiler casing, containing quarters for the engineers. The petty officers are housed aft and the crew forward under the shelter deck.

Two of the vessels are to be built and classed to the rules of Lloyd's Register of Shipping, class 100 A-1, while the other two are to be built and classed to rules of the American Bureau of Shipping, highest class, and rules of Lloyd's Register of Shipping, class 100 A-1, for vessels carrying petroleum in bulk. All vessels are to pass the United States Steamboat Inspection laws and the requirements of the Suez and Panama Canal authorities.

The general dimensions of each ship are as follows:

Length overall	485 feet 0 inches
Length between perpendiculars	468 feet 6 inches
Beam, molded	62 feet 6 inches
Depth, molded to shelter deck	39 feet 6 inches
Depth, molded to upper deck	32 feet 0 inches
Draft, loaded to summer freeboard	27 feet 1 inch
Deadweight on 27-foot 1-inch draft	12,620 tons
Indicated horsepower	3,200
Speed	11 knots

The vessels are designed with deadweight capacity of 12,620 tons, and are to carry 11,630 tons of refined oil at 6¾ pounds per United States gallon in the main and sum-

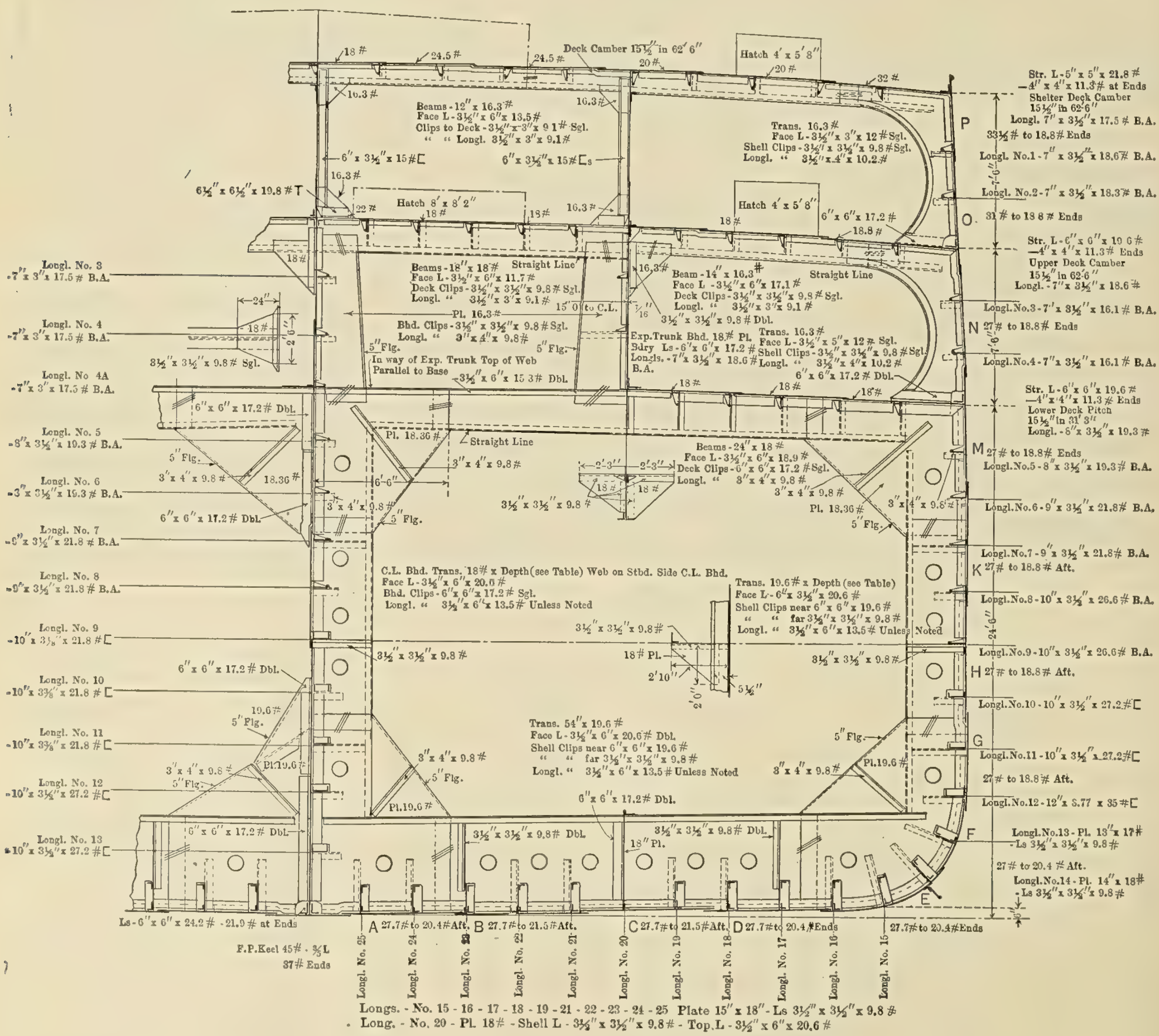

Fig. 1.—Midship Section, Showing Principal Scantlings

TANK STEAMER OF 12,620 TONS DEADWEIGHT

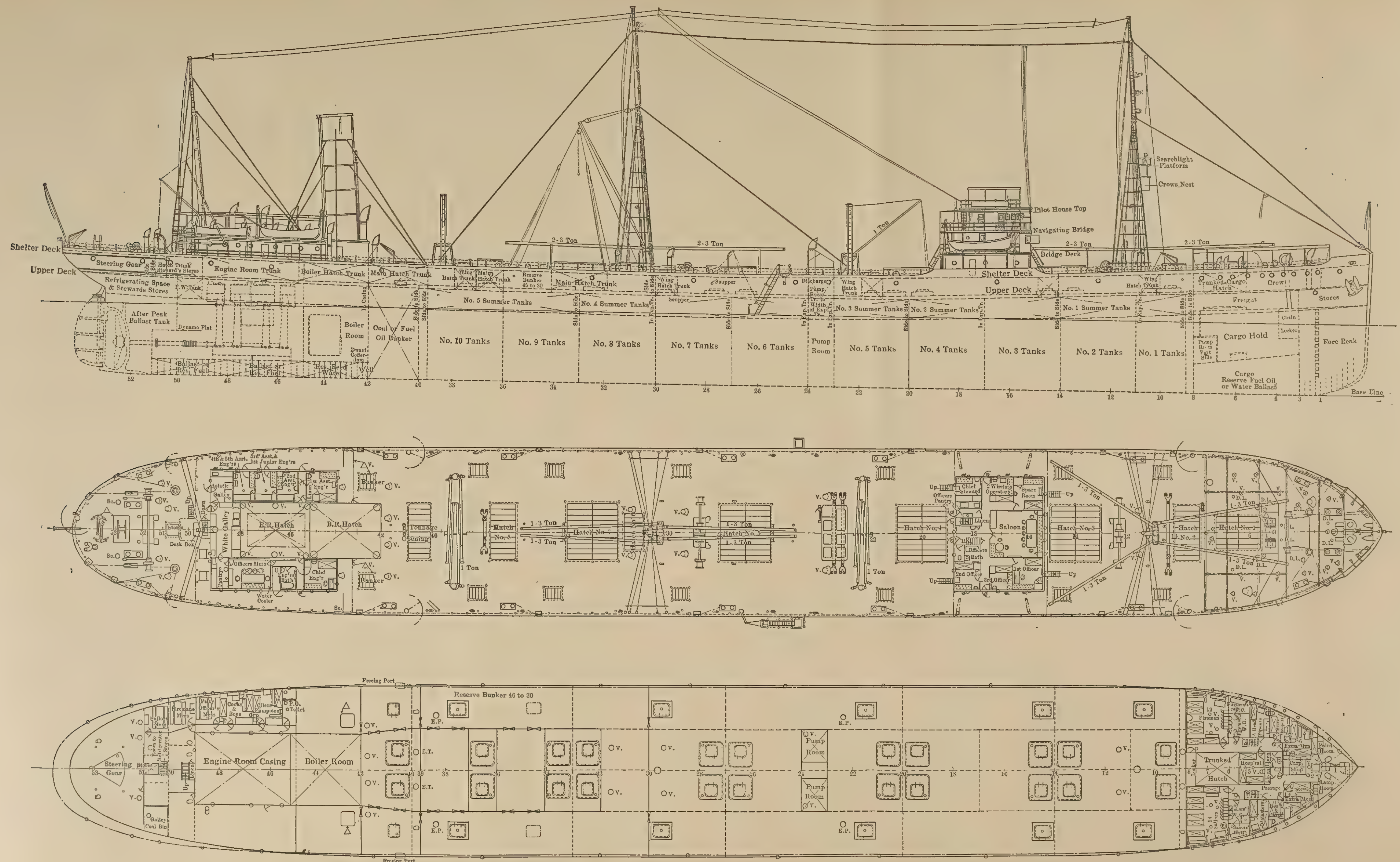

Fig. 2.—Profile and Deck Plans: Length Overall, 485 Feet; Length Between Perpendiculars, 468 Feet 6 Inches; Beam, Molded, 62 Feet 6 Inches; Depth, Molded to Shelter Deck, 39 Feet 6 Inches; Indicated Horsepower, 3,200; Speed, 11 Knots

mer tanks, together with 750 tons of fuel oil in the cross bunkers; 200 tons of fresh water in the reserve feed water and after tanks in the boiler and engine rooms; 40 tons of stores and crew's effects on a draft of 27 feet 1 inch, even keel, in salt water, and trim about 6 inches by the stern; the block coefficient at this displacement not to exceed 0.803.

The main and reserve fuel tanks and main and reserve coal bunkers are designed for a capacity of about 40 days' supply. The main cargo tanks will have a capacity of 3,665,700 United States gallons, and the summer tanks a capacity of 507,200 United States gallons. All tank capacities are designed with 3 percent allowance for expansion.

General Arrangement

Built on the longitudinal system of framing, the hold is divided into ten tanks for carrying cargo oil with a centerline bulkhead, extending to the upper deck, dividing the tanks into starboard and port compartments. The space in way of the expansion trunk at the sides of the ship are divided into five compartments on each side, to be used for summer oil tanks. The hold forward of the cargo oil tanks and the space under the shelter deck forward of the bunker are for package freight. Cofferdams are fitted between the cargo hold and the cargo oil tanks forward, and between the fuel oil tank and the cargo oil tanks aft.

The pump room is located amidships, and there is a reserve oil and ballast tank under the forward hold. The machinery is located aft, with a double bottom under the boiler and machinery space.

There are three decks, the main, upper and shelter. The space under the shelter deck abreast of the boiler casing extending forward to amidships is arranged for bunkers. The fuel tank is arranged to carry either coal or oil.

The cargo oil and summer tanks and fuel oil tanks extend to the upper deck only, and the space at the hatches between the main and shelter decks is bulkheaded off from the rest of the shelter deck to prevent fumes from settling under the shelter deck.

The vessel has three steel pole masts, schooner-rigged, and the equipment is up-to-date in every respect, including all modern appliances.

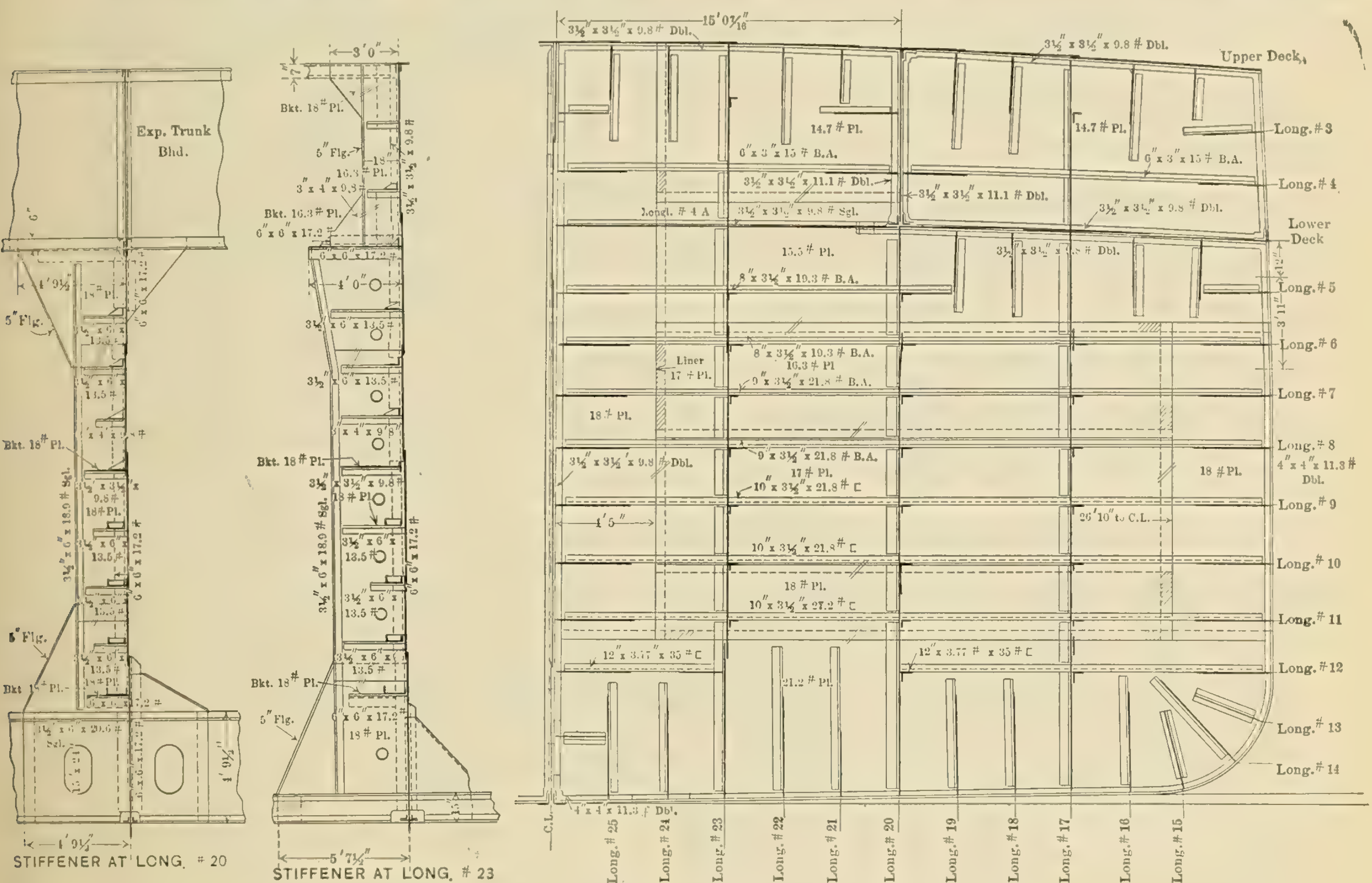

Fig. 3.—Typical Bulkhead, Showing Details of Stiffeners

Machinery

The propelling machinery consists of one quadruple expansion surface condensing engine designed to develop approximately 3,200 indicated horsepower at 76 revolutions per minute, which, it is estimated, will give the vessel a speed of 11 knots. The cylinders are 24 inches by 35 inches by 51 inches by 75 inches, with a common stroke of 51 inches. Each cylinder is supported by four strong cast iron columns.

The air, bilge, sanitary and evaporating pumps work from a pair of double levers off the low pressure cylinder of the main engine. The two independent centrifugal circulating pumps are driven by independent engines.

The high pressure and first intermediate pressure cylinders have trick piston valves, while the second intermediate and the low pressure cylinders are fitted with double-ported slide valves. The valves are controlled by Stephenson double bar link motions, with hand and steam reversing gear. The steam reversing engine has a 14-inch cylinder by 22-inch stroke. The engine is equipped with an Aspinall automatic engine governor.

The condenser is independent and is of cylindrical type.

having 5,600 square feet of cooling surface. The shell is of steel with cast iron water chest and cover, having usual handholes and manhole.

The propeller is four-bladed, 19 feet 6 inches diameter by 14 feet 9 inches adjustable pitch. The blades are of manganese bronze with cast steel boss. The propeller shaft is of forged steel 15¾ inches diameter.

A two-ton Brunswick direct expansion refrigerating machine is installed on the starboard side in the engine room gallery in a separate enclosure with watertight door.

The steering gear is a right and left screw gear actuated by a double cylinder 10-inch by 10-inch steam engine. The screw gear is directly connected to a floating crosshead and tiller, the tiller being connected to a quadrant through spring buffers. The quadrant is keyed to the rudder head and is fitted with a friction hand brake for holding the rudder when necessary. The steering gear is controlled from the pilot house by a hydraulic telemotor and from the docking bridge by a shaft transmission gear.

Two General Electric engine-driven generating sets each of 20 kilowatts capacity supply electric lights for the vessel.

Three single ended Scotch boilers 15 feet 3 inches mean inside diameter by 11 feet 6 inches long over heads supply steam at 220 pounds per square inch working pressure. Each boiler has 3,100 square feet of heating surface and is arranged with Howden's system of forced draft and equipped with mechanical fuel oil burners. There is also a coal burning vertical donkey boiler 3 feet diameter by 6 feet 9¾ inches high, working at 125 pounds per square inch pressure and having 160 square feet of heating surface located in the lower fireroom.

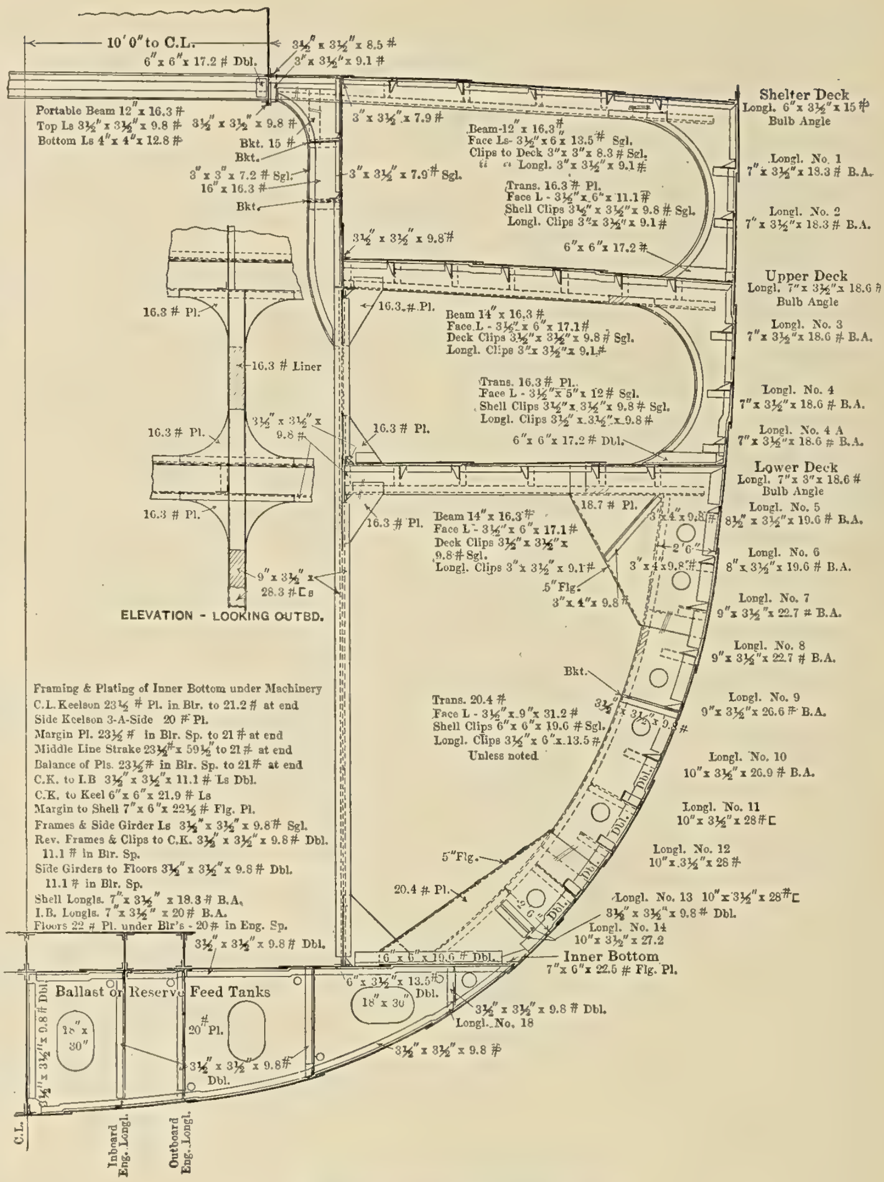

Fig. 4.—Framing in Engine Room

A steam windlass 14 inches by 12 inches is located on the shelter deck and operated by a vertical inverted double engine located below the deck. Quick-warping heads 20 inches diameter by 24 inches wide are fitted to windlass. Three double geared reversible warping and hoisting winches having two cylinders 9 inches diameter by 12 inches stroke are located as shown on the plans.

A study of the plans will clearly show that these vessels are unusually fine specimens of the highest type of American steel shipbuilding and will be a credit to the owners and builders.

Proposed Anglo-American Standards for Rolled Steel Shapes

It may not be generally realized that approximately 75 percent of the world's demand for steel is specified to either American or British standards; but, unfortunately, the standards in vogue in these two countries and their dependencies have hitherto varied to such an extent as to introduce annoying difficulties in the way of interchangeability. The rolled steel shapes used in building structures, bridges, railroad cars and ships are notable in their points of difference, for not only do their contours and ranges vary, but a different language is used in dimensioning their thicknesses. While some steps were taken during the war looking to the adoption of international standards for shapes used in shipbuilding, these were primarily of an emergency nature and did not attempt to cover other branches of industry.

During the year 1919 the British Engineering Standards Association undertook the revision of their standards for rolled steel shapes, and following a visit of their secretary to this country they sent a formal invitation to the American Engineering Standards Committee to co-operate in the possible adoption of Anglo-American standards for these shapes. Under the auspices of the American body the following organizations were requested to confer on the proposed standardization:

United States Navy.
Association of American Steel Manufacturers.
American Bureau of Shipping.
American Society of Civil Engineers.
American Railroad Association.
Society of Naval Architects and Marine Engineers.
Railway Car Manufacturers' Association.

Fig. 1.—U. S. S. Destroyer *Clemson*: Displacement, 1,200 Tons; Horsepower, 28,000; Speed, 35 Knots

All of these organizations accepted the invitation with the exception of the American Railroad Association, which is unable to act at this time, but may do so later on. The Canadian Engineering Standards Association has also been invited to co-operate, but has so far not been able to do so actively. A number of conferences have been held, and on April 27 the committee formulated a complete preliminary report for transmission to the British Engineering Standards Association as a basis for discussion on common Anglo-American standards.

The representatives are as follows:

United States Navy:
- Commander C. M. Simmers.
- Lieut. Com. H. D. Rouzer.

Association of American Steel Manufacturers:
- R. B. Woodworth (chairman).
- G. H. Blakeley.
- G. E. Thackray.

American Bureau of Shipping:
- Captain C. A. McAllister.
- David Arnott.
- John Martin.

American Society of Civil Engineers:
- J. H. Edwards.
- J. B. French.
- H. G. Balcom.

Society of Naval Architects and Marine Engineers:
- Fred T. Llewellyn.
- E. H. Rigg.
- J. W. Stewart.

Railway Car Manufacturers' Association:
- A. E. Ostrander.

The representatives of the various organizations referred to above are known as the "Sectional Committee on Steel Shapes" of the joint sponsor bodies—the American Society of Civil Engineers, the Association of American Steel Manufacturers, and the Society of Naval Architects and Marine Engineers—and they are very anxious to get a full and free discussion of the whole subject by anyone interested. Criticisms or suggestions will be cordially welcomed by the committee. Communications should be addressed to Dr. P. G. Agnew, secretary, American Engineering Standards Committee, 29 West 39th street, New York City.

Geared Turbines for Torpedo Boat Destroyers

THE U. S. S. *Clemson,* which recently went into commission, represents our latest type of torpedo boat destroyer. This vessel has a displacement of 1,200 tons, a speed of 35 knots, and an engine power of 28,000 horsepower. This engine power, it is interesting to note, is the same as that for the 30,000-ton, 21-knot, electrically-operated battleship *Tennessee,* and, since the propelling machinery of the destroyer is crowded into one-tenth the space available on the battleship and is handled by less than one-fifth the men, it is evident that this machinery must possess special features of compactness and simplicity.

The arrangement of the destroyer's engine room is shown in the diagram Fig. 2. Each of the two propellers

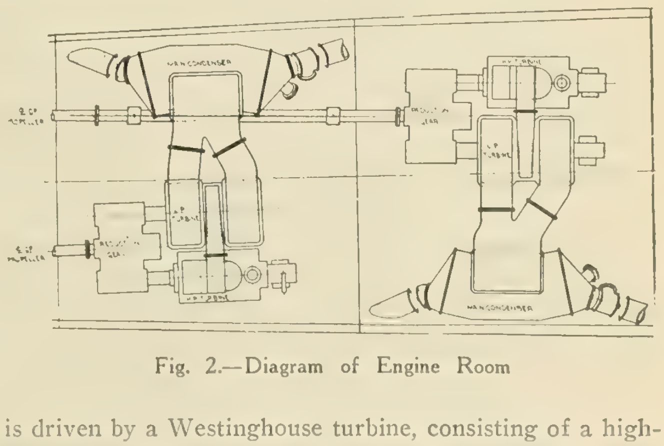

Fig. 2.—Diagram of Engine Room

is driven by a Westinghouse turbine, consisting of a high-pressure and a low-pressure element, geared to the propeller by means of a floating-frame type of gear. Normally both elements drive their propeller together, but if either is out of commission the other can be used alone, although the propeller speed will, of course, be reduced.

The total weight of these two turbines with their gears is 76 tons, and the deck space occupied, including auxiliaries, is 1,550 square feet. These figures can be compared with 615 tons and 12,000 square feet, which are the weight of and the space occupied by the *Tennessee's* machinery. The difference in favor of the destroyer's

S. S. *Dumosa* on Her Trial Trip. The Vessel Was Built at the Commonwealth Government Dockyard, Williamstown, Australia, and Has a Deadweight Capacity of 5,600 Tons on a Draft of 21 Feet 9 Inches

equipment is due principally to the high speed of the vessel, which permits a propeller speed of 450 revolutions per minute (as compared with 170 revolutions per minute for the *Tennessee*) and a correspondingly higher speed of the turbines. Regardless of this, however, this installation illustrates the compactness of the geared turbine unit.

Each turbine unit consists in reality of three separate turbines: (1) the main high and low pressure portions for running at high speeds; (2) a cruising turbine for speeds of 15 knots and less, which is mounted in the high pressure casing; and (3) an astern turbine, which is mounted in the low pressure casing.

This arrangement is quite different from that used on the older 750-ton, geared-turbine driven destroyers *Mayrant* and *Henley*. In these latter vessels the high and low pressure elements of the main turbine are in the same casing, while the cruising turbine is separate, being geared to the main turbine. When the main turbine of this latter type is in use, the cruising turbine is disconnected by means of a clutch, and when the cruising turbine is in use it drives the propeller through the main turbine, which turns idly. This method permits better steam economy, especially at cruising speeds, than that used in the *Clemson* type, but space limitation prevents its use on the later destroyers.

Each astern turbine of the *Clemson* develops about 5,000 horsepower. The maximum astern speed is about 22 knots, and the change from full speed ahead to full speed astern can be made in less than two minutes.

The performance of the *Clemson* is as follows:

Speed in knots	35	25	20	15	12
Shaft horsepower	28,000	10,000	4,200	1,500	750
Guaranteed steam consumption	10.75	10.75	12.0	15.1	18.5

On unofficial trials she developed a shaft horsepower per hour on slightly less than one pound of fuel oil at 30 knots, and on slightly more than one pound at 35 knots.

Trials of the Fourth Australian Standard Steamer

The S. S. *Dumosa*, the fourth vessel to be completed under the Australian Commonwealth shipbuilding scheme, and the second of her class built at the Commonwealth Government Dockyard at Williamstown, ran satisfactory trials on February 17. The usual steering and full power trials were carried out to the satisfaction of the various officials present.

Hull Data

The vessel has a length of 341 feet, a breadth of 48 feet and a molded depth of 26 feet 1 inch. She is built on the Isherwood system of longitudinal framing and is a single-deck type vessel, with poop, bridge and forecastle, classed 100 A-1 by Lloyds. She has exceptionally large hatches and ample cargo-handling equipment, consisting of eleven winches and eleven derricks, including one 20-ton derrick. The vessel will carry 5,600 tons deadweight on a draft of 21 feet 9 inches.

The captain and officers are berthed amidships, the engineers on the bridge alongside the engine casings, and the crew in the poop. All accommodations are ample in size, with separate messrooms for the firemen and sailors, as well as baths and washrooms.

Propelling Machinery

The machinery consists of triple-expansion engines with cylinders 25, 41 and 68 inches diameter by 45 inches stroke, and three Babcock and Wilcox watertube boilers, designed for a working pressure of 180 pounds per square inch. The machinery was constructed by Messrs. Thompson & Company, Castlemaine, Victoria. With the exception of a portion of the steel plates, special parts for the boilers and a few items of equipment, the material and auxiliaries were manufactured in Australia.

Observations Here and There

BY "OLD SCOTCH"

SEVERAL years ago, many readers may remember, I contributed a series of articles on economy in ship operation with particular reference to the engine room, where success or failure is most likely to be started in running ships. Along came the war and economy in everything was thrown to the winds and I had to duck under to avoid the orgy of spending which was started then and still continues. The ominous clouds of extravagance are beginning to break away, so I am going to venture from my retreat, and by permission of the new management will periodically break out with a few remarks on the passing marine show, which from now on promises to provide many interesting phases for such remarks.

Whereas in former papers reference was made to possible savings in fuel, oil, stores, etc., such items were mere economies at the spigot, and the bunghole was unprotected. Now, nationally, we have had a rude awakening and our first efforts must be to chop down the big extravagances. Why, for example, have we been contented to spend from $300,000,000 (£63,000,000) to $400,000,000 (£82,000,000) per annum for many years past to foreign shipowners to carry our exports and imports for us? Our low ebb was reached in 1910, when we supinely permitted only 8.7 percent of our goods to be carried to and fro over the oceans in American ships. Last year we had remedied this state of affairs to the extent of carrying 27.8 percent of goods in American bottoms. Of course, in the very nature of trade we cannot expect to carry all of our goods back and forth, but we should reasonably aspire to carrying 60 percent of our water-borne commerce. All the nations with which we trade do not have their own merchant marines, so 10 percent over the half of our foreign commerce is but a reasonable expectation for us to assume. The aftermath of the war has left us with the ships in which to carry that proportion of our foreign commerce; all we have to do is to so encourage our shipyards, shipowners and ship operators to keep this fleet up and operating as economically as possible to insure our getting the 60 percent of our ocean-carrying trade to which we are rightfully entitled.

For many years I have watched and prayed that our congressional representatives could see the light and not be misguided by foreign propaganda into enacting legislation to hinder our shipping efforts, instead of helping it. If my prayers haven't been answered, somebody has performed a better praying job than I am capable of, for unless all signs fail the pending shipping bill in Congress will come pretty near to satisfying our most ardent desires so far as the restitution and continuance of our merchant marine is concerned. It's a real American bill from stem to stern and backed by the right spirit. Just listen to this, all ye old-timers who have for many years all but given up hopes for the American merchant marine; this is what the commerce committee of the United States Senate said unanimously in reporting favorably on the Jones bill:

"No interests but American interests have been kept in view. We are sure that other nations will look after their citizens and their needs, and if our business is to be cared for, we must do it. Years ago our great commercial rivals said, 'To Hell with American ships!' That spirit exists today."

Then follows the following comment quoted from England's great shipping paper, *Fair Play*:

"We have always been generous and, in the matter of our interpretation of free trade, fools; but when it has been a question of the survival of the fittest, we have invariably done our level best to crush or mold opposition, and, as regards America's new mercantile marine, we shall go on doing it and expect her to do the same by us."

There you have the issue in language as plainly as it can be expressed. All honor and glory to our senators who thus accept the gage of battle and are willing to back up our shipping people in making the fight. Whatever else may be said of our English friends, they always fight fair, and we of the same blood fight the same way. Heretofore we have been fools in everything that pertains to our own rights by giving everything away in a supinely generous spirit, borne of a general don't care attitude concerning matters international. Even today there are many among us practicing that same carelessness of our rights and interests, as evidenced by the vast sums we are paying out to foreigners for marine insurance and its hand-maiden—foreign classification of our ships privately owned. Our Shipping Board is awake to these conditions and has recently issued an order to have all the Board ships heretofore classified by aliens taken over into American classification. It will shortly be announced by the Shipping Board that satisfactory arrangements have been made with the leading American underwriters whereby the great majority of marine risks on American vessels, both publicly and privately-owned, will be taken by syndicates composed of American companies. This will result in keeping approximately one hundred and fifty millions of dollars (£30,800,000) annually in this country, where heretofore that amount has been sent abroad to alien underwriters. This will stop another great leak in our national finances, and will be a great help in the maintenance of our new merchant marine against foreign competition.

We have been so accustomed in this country to taking the little end of the stick in maritime matters that it is very refreshing to all true Americans to note the change of attitude of our legislature and those in Governmental authority over navigational affairs. Our one supremacy on the ocean has for the past half a century been the fact that periodically we have produced a yacht which could outsail all competitors. Even that supremacy is to be given a severe test in a few months. The *Shamrock IV*, the latest competitor from the other side, is at present in an American yard being groomed for the great international contest.

The original race for the Queen's cup, when the yacht *America* took her blue ribbon of the seas away from England, was notable as a contest between two widely divergent types of sailing craft. The *America* was of the then common skimming-dish type, fitted with a centerboard. Her antagonist was of the cutter type, small beam and great draft. It is not generally well known, but a fact nevertheless, that both the American and English yachts this year will be closely alike, and that each will have a centerboard—in fact, the *Shamrock IV* has two centerboards of the so-called "dagger" type operated from a common centerboard trunk. The net result of this long series of contests will be that the outstanding features of both the original yacht types have now been combined and adopted by the representatives of both nations.

Another interesting fact is that both the American contestants for the honor of competing with the visiting yacht are of metal—one of steel and the other of bronze—whereas the green-hulled boat from the other side is of

wood with practically no frames. May the best boat win, say all fair-minded persons, but we on this side naturally place our hopes on the Yankee craft. If we are going to win with our merchant marine, we must put our best foot foremost and pay attention to every detail, as we have always done with our yachts.

Have you noticed the nation-wide publicity propaganda regarding American ships and shipping now being put out by the Shipbuilders' Association? They are spreading broadcast, in very attractively-worded advertisements in the leading papers, the salient facts both historical and contemporaneous in connection with shipping generally. It is a liberal education in maritime matters to read these pronouncements. This is splendid work and shows that the American shipbuilders are alive and on the job. Their contention is that the best policy to pursue for the sale of Government-owned ships is to make the operation of ships under the American flag profitable to shipping men and to investors in ship securities.

In that they are entirely right, and I can foresee very beneficial results to our merchant marine accruing from this campaign of publicity. In this matter shipbuilders have taken their cue from the American railroad executives, who before and during the discussions of the recently adopted constructive railroad legislation in Congress used the power of the press in setting forth straight-out facts concerning the problems which confronted them. By this means the voters at home became informed as to the reasons which guided their representatives in Congress to vote for that particular piece of constructive regulation. By the combined efforts of railroad managers and shipbuilders the American public will become educated in the vital problems of transportation both on land and sea, which are so essential to our well-being and comfort.

While this legislation is pending in Congress there is a notable slackening up of marine activities both in shipbuilding and ship operating. All eyes are turned towards Washington. If the present Senate bill is enacted into law without any vital changes, as now seems apparent, the American merchant marine will take a new and strong stand for the fierce competition which awaits it on the reassumption of normal conditions in sea trade which seem to be fast approaching. Already the swollen freight rates, whereby anybody could operate anything that floated with reasonable chances of success, are shrinking. To give an idea of the direct relation which ocean freight charges bear to our everyday existence, we have only to imagine the problems of living on the other side of the Atlantic. Owing to the great shortage of coal, due to the ravages of war, thousands of tons must be shipped from this side. To an initial cost of six to seven dollars (1/5/0 to 1/9/2) per ton here at the port of departure must be added a minimum freight rate by sea of twenty dollars (4/3/4) per ton to a seaport in Continental Europe. Imagine the problem confronting you, if you lived at an interior city in France or Italy, and had to lay in your winter's supply of that most necessary element of future comfort. If the local coal dealer be a profiteer, as most likely he is, your bank account would be set back at the rate of about forty or fifty dollars (8/6/8 or 10/8/4) for every ton of coal you laid in. Thank God every day that you are living in America, and pray for a good merchant marine.

Special Committee of Business Men Recommends Terms for Sale of Shipping Board Vessels

EUGENE MEYER, JR., managing director of the War Finance Corporation, chairman of the special committee appointed by Admiral Benson, chairman of the Shipping Board, on April 15 to make recommendations as to prices, terms and conditions for the sale of ships now owned or being constructed by the United States Shipping Board, has submitted the following report:

"Your committee understands that a decision has been reached to sell the ships now owned and under construction by the United States Shipping Board, and, furthermore, that the resolution as passed at the meeting of the general committee stated that the ships should 'be sold at such prices and on such terms as will encourage the investment by shipping interests to the end that the merchant marine of the United States may be firmly established.'

"Your committee understands that it was appointed for the purpose of making informal suggestions of general terms upon which it would seem appropriate to dispose of the ships.

"Your committee understands that its suggestions concern only the sale of ships that the Shipping Board considers desirable to be retained for the permanent American merchant marine; and further that it is not expected to deal with special phases of the shipping problem such as are involved in the question of maintaining special trade routes which may be desirable in the national interest.

PRICES

"With regard to prices, the committee recommends that (1) as the ships were built as a war measure and in a period of abnormal and excessive cost, due to war conditions and to the fact that the industry had to be built up as a substantially new industry in this country, the abnormal cost should be absorbed as war waste, and that the prices should be fixed upon the basis of present prices for reproduction, considering both foreign and domestic production costs; and that (2) the prices should be determined in a manner to assure stability, either by fixing prices for ships of given types and tonnages which could be maintained over a period sufficiently long to give buyers the assurance that after they have contracted for purchases of ships they will not be placed at a disadvantage by subsequent reduction in prices, or by fixing prices with definite protection to buyers over a definite period, such protection to consist of an arrangement under careful safeguards for price readjustment should it subsequently prove necessary or desirable for the Shipping Board to reduce prices.

TERMS OF SALE

"With regard to terms, your committee suggests as follows: Ten percent cash payable on delivery of the ship, with payments at the rate of five percent semi-annually for three years, making a total of forty percent to be paid in by the end of the third year; the balance, or sixty percent, to be payable in twelve yearly installments of five percent each. In connection with these terms, which have been arrived at with a view to making it possible under present financial conditions for buyers to arrange the necessary financing, your committee recommends that purchasers be required to render carefully supervised and audited accounts of operations and earnings on these ships in such a way as seems well to your Board. Out of the earnings, after providing for the interest, taxes and current installment payment on account of principal, an adequate return on the actual capital invested should be allowed the purchasers; after such adequate return on the investment at a rate to be fixed by your Board, surplus net earnings should be applied to additional payments of the installments of principal. The committee would consider it preferable to have the anticipation of such installments, if any, applicable to the last installments due, but feels that a certain amount of discretion should be exercised upon this point by your Board, and it may be advisable to have this clause contain some elements of elasticity so that anticipated installments may be in whole or in part applied to installments falling due in a period of possible business depression.

"The committee recommends that interest be charged at the rate of six percent per annum, and the Shipping Board should

have full protection by insurance on all marine risks and fire. Title should remain in the United States Government, with proper protection to it by purchaser's bond or otherwise, until a proportion of the total principal amount of the purchase price, to be fixed in the discretion of your Board, shall have been paid over, after which it would appear proper to pass the title and take a first lien with proper safeguards on the vessel as security in the legal form suitable for such business.

"The committee suggests that a discount of five percent for cash payment in full on the delivery of the ship be allowed. In cases where cash is not paid in full on delivery of the ship, the committee suggests the buyer be given the right of a cash discount of two and one-half percent in case of full payment for the ship at any time within five years from the date of delivery. It appears to the committee that in case of default of principal or interest, the Government should have the right immediately to repossess any ships sold under a contract, and the Government should have the right to resell such ships as may be taken over at public or private sale, the net surplus, if any, after deduction of all indebtedness, to be paid out to the obligor.

"Your committee suggests that in view of the small cash payments required under the above recommendations, the Board use careful discrimination as to the responsibility of purchasers, whether the purchasers be large or small. The committee ventures to emphasize the point of 'responsibity' of the purchasers because the committee feels that in a considerable degree methods which restrict sales to responsible parties will give greater confidence to the class of buyers who desire to go into the shipping business in a substantial and permanent manner. In using the word 'responsibility,' the committee has in mind not only the character and resources of the parties concerned, but also their ability to handle the business competently and efficiently. Smaller concerns may be as responsible for moderate commitments as larger concerns would be for larger commitments.

"Your committee suggests that parties making purchase contracts should be protected against unequal competition from operating contracts upon unduly easy terms in connection with ships still unsold.

"In conclusion, your committee suggests that it would seem proper, in view of the fact that the ships constitute a capital asset of the United States Government, that the funds received on account of repayment of principal should be applied to the redemption, at the market prices, of Liberty Loan Bonds or Victory Loan Notes. Should your Board have occasion to recommend legislation to Congress, your committee suggests that you include a recommendation to this effect."

Meters and Inches

BY PROFESSOR C. H. PEABODY*

A MAN has five fingers on his hand; hence the decimal system, which in ways is inconvenient. If a man had four fingers, we should have the binary system; if he had six fingers, we should have the duodecimal system. Each of the two systems last mentioned is so convenient that they are persistently used and will continue to be. It is probable that either, once established with its proper notation and means of computation such as multiplication table and logarithms, could dominate the mathematical world. So much for the sacrosanct decimal system. But the decimal system now established will always remain dominant, though enthusiasts may dream of reformation.

The apotheosis of the decimal system is found in the metric system, which truly has its inconsistencies and inconveniences; but it serves where it is in use and will continue, probably squeezing out the remnants of older systems, though the process is less rapid and perfect than its protagonists represent. It is most amusing to compare the maps issued by the propaganda for the metric system and the maps of the defenders of the dominant industrial system of Britain and America. The aberration of statistics seems to have run wild in these maps.

Without going into statistics, it may be claimed that the English inch is now the dominant unit of length in the industrial world; roughly, its dominance can be represented by the fraction three-fourth. This does not mean that it will become universal; we are probably doomed to have two systems of weights and measures and to get along as best we may under that condition. But most of the world knows one system or the other; and using habitually one system and having no knowledge of the other has little occasion to worry. In fact, nobody appears to worry except certain reformers and those whom they worry by threatening legal enactments.

Let it now be boldly said that the system of weights and measures of the British Empire and the United States cannot be changed. Congress has great power and Parliament is not even limited by a written constitution, but singly or both together they cannot change the practical use of the systems of weights and measures of their countries. Both deliberative bodies have in them men of information and common sense, and it most unlikely that either will attempt legislation looking toward the substitution of any other system in place of the one now in use. But there is just enough chance that something may be slipped over to worry the engineering world and make it necessary to meet propaganda with propaganda because the mass of people do not know that it can be done. In fact, a considerable number of scientists and enthusiasts think it can be done.

There are three arguments in favor of a change: (1) that the metric system is scientific, (2) that it is more convenient, and (3) the advantage of uniformity. Taking the last first, we can but admit it; it would be a good thing if we could get it. There is no evidence that meters are more convenient than inches; perhaps the latter have the advantage. Scientists use the metric system and for their purpose it is convenient, but its advantages are too much extolled. Probably, if scientists were trained on the English units, they would get along very comfortably.

At one time the United States army had a practical cap, a sensible cap; such as a civilian would wear. It came between the old civil war style and the English style now in use. The only fault found with it was that it was not military. A hard-headed American officer gave the real reply to this criticism. He said that a military cap was a cap worn by military men. Now the writer has had occasion to use both systems of measure and to transform from one to the other, and after a study of the original pretensions of the metric system and its real status he is of the opinion that it is scientific because scientists use it.

Three centuries ago tramways were laid in England for hauling coal. The wagons then in use had a gage of four feet eight inches and a half. So in 1814 Stevenson's locomotive had the same gage and now the standard gage of England and America is four feet eight inches and a half. Let the proponents of the metric system undertake to increase this gage by the amount of two inches and a half, to 1.5 meters, and then let them pause before attacking the standard airbrake fittings.

There are three English institutions that need reformation. Naming them in the order of difficulty (if such an expression is proper concerning what cannot be done), they are the English language, the English weights and measures, and the English money. An English commission has just reported adversely concerning a proposed change of money to a decimal system.

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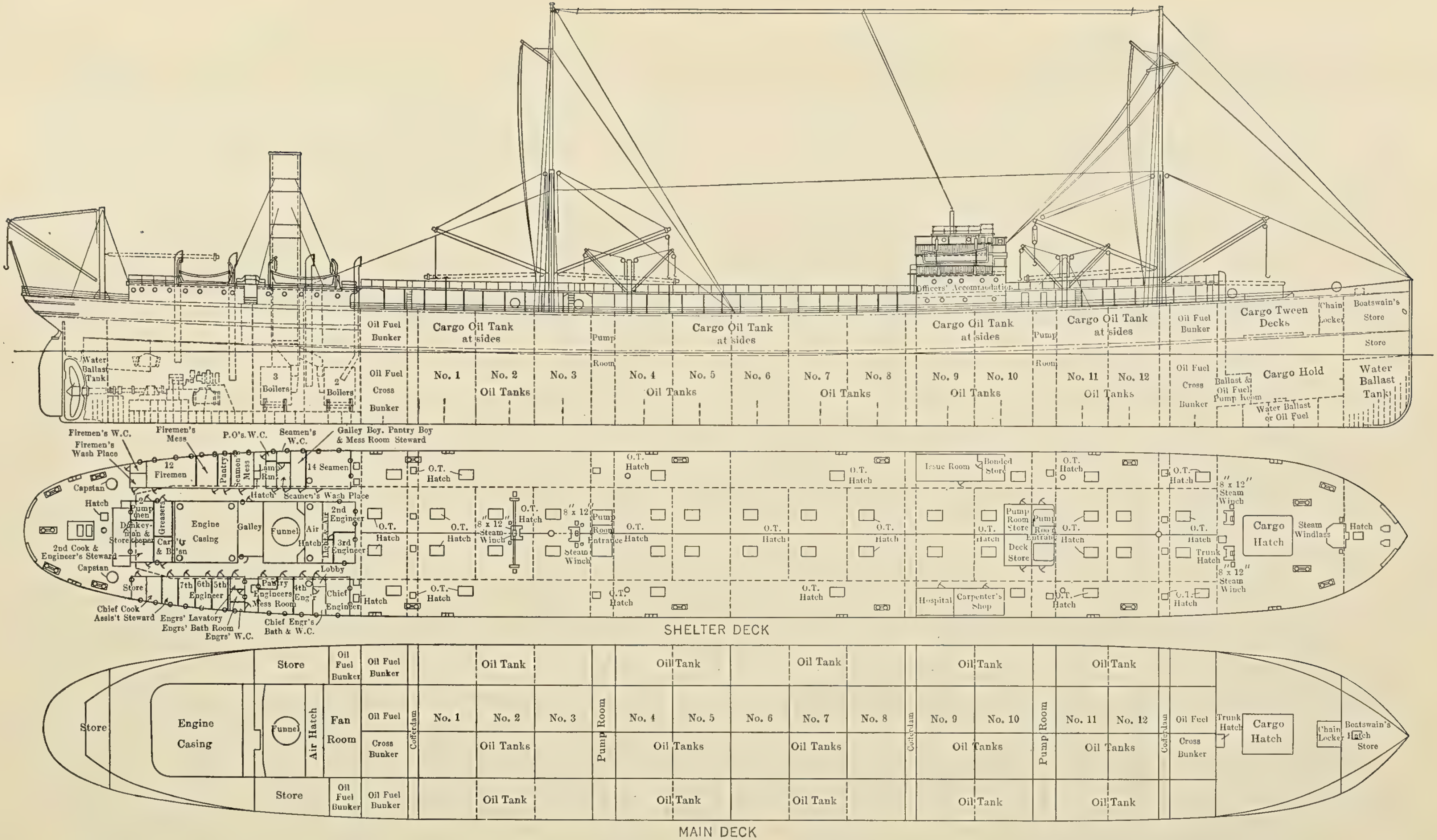


Fig. 1.—Profile and Deck Plans of 18,000-Ton Oil Tanker *San Fernando*: Length Overall, 547 Feet; Length Between Perpendiculars, 530 Feet; Breadth, Molded, 69 Feet; Depth, Molded, 42 Feet 3 Inches; Deadweight Tonnage at Maximum Draft of 30 Feet 8¼ Inches, 18,550 Tons

Oil Tank Steamer San Fernando

Largest of the New Fleet of 18,000-Ton Steamers Building for the Eagle Oil Transport Company, Limited

BY MAJOR F. C. COLEMAN

SIR W. G. ARMSTRONG, WHITWORTH AND COMPANY, LIMITED, has just completed at the Walker shipyard, Newcastle-upon-Tyne, the *San Fernando,* which is the largest oil tank steamer afloat, and one which illustrates the best present-day practice in the construction of this type of vessel. The *San Fernando* is one of the latest class of oil tank steamers constructed for the Eagle Oil Transport Company, Limited, and is a development of the 15,000-ton oil tank steamers which were constructed some four or five years ago for this firm by various shipyards on the northeast coast, three of these vessels being built at the Walker shipyard. The steady increase in size of the oil tankers in this company's fleet is very marked, previous vessels built for them being 9,400 and 15,000 tons deadweight.

With regard to the propelling machinery the same progressive spirit is shown by this firm, as the *San Fernando* and sister ships are engined by double-reduction geared turbines of the Brown-Curtis type, superheated steam being supplied to these engines from five cylindrical boilers fitted with oil fuel burning installations. This system is the latest development in marine steam engineering, and is undoubtedly the most economical form of steam propulsion extant.

The *San Fernando* is of the single deck and shelter deck type, and, like all the other large oil tank steamers owned by the Eagle Transport Company, Limited, and similar companies, is built on the Isherwood system of framing, which gives certain advantages for vessels of this type.

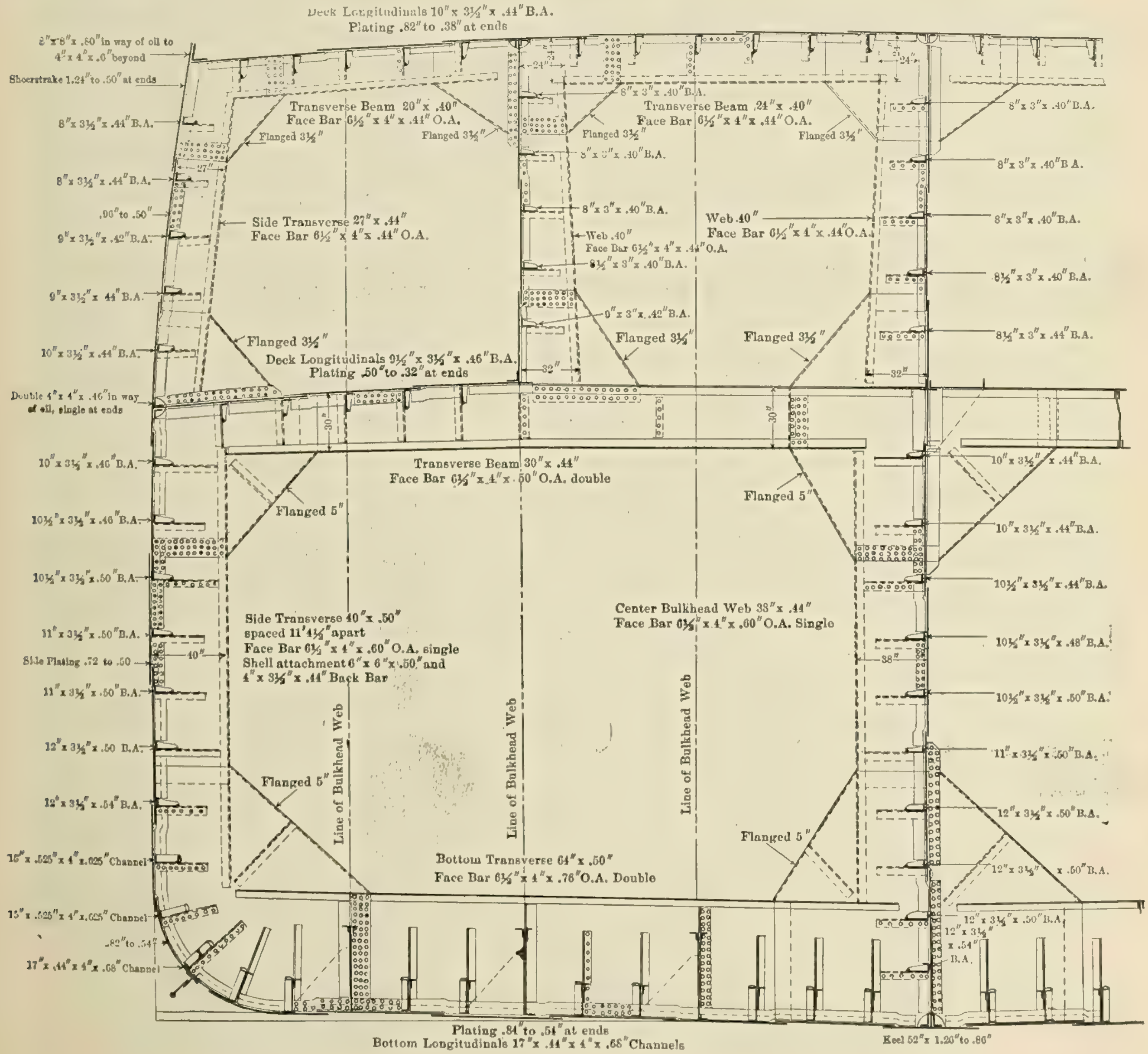


Fig. 2.—Midship Section, Showing Principal Scantlings

Fig. 3.—18,000-Ton Oil Tank Steamer *San Fernando* Built by Armstrong, Whitworth and Company, Ltd., Newcastle-Upon-Tyne, for the Eagle Oil Transport Company, Ltd., London

The various scantlings are, in many cases, increased over those required by Lloyds Registry, the thickness of the sheer strake and shelter deck plating, for example, being considerably in excess of that required by this society. This increase was made in order to give additional longitudinal stiffness.

The principal dimensions of the *San Fernando* are:

	Feet	Inches
Length overall	547	0
Length between perpendiculars	530	0
Breadth molded	69	0
Depth molded	42	3
Height between shelter and main decks	15	0
Extreme draft of water	30	8¼
Deadweight at above draft, 18,550 tons		

It will be seen from the drawings that the main cargo space of the vessel is divided into fourteen oil tanks, each about 22 feet 6 inches long, these tanks being further subdivided by a central longitudinal oiltight bulkhead which continues through the various pumping rooms and cofferdams. The foremost and aftermost of these tanks are fitted up as oil fuel bunkers, the deep double bottom in the cargo hold forward being also utilized for this purpose.

In the earlier tank steamers—which were of small dimensions, and which, as a rule, only carried one class of oil of light specific gravity—it was the custom to fit only one pump room, usually at the after end of the cargo oil tanks. Owing, however, to the greatly increased size of these vessels and the different varieties of oil, it has since been found essential to fit two pump rooms, the position of them being chiefly determined by the necessity of fitting the minimum lengths of suction pipes.

As the transverse bulkheads forming these pump rooms extend to the shelter deck, it will be seen that these compartments form additional cofferdams. The oil fuel bunkers are divided from the oil cargo tanks by cofferdams, and there is an additional cofferdam fitted between tanks Nos. 8 and 9.

By this arrangement the cargo tanks are divided into four self-contained groups, which, as already mentioned, are further subdivided by the central longitudinal bulkhead, thus enabling a variety of oils of different qualities and specific gravities to be carried without coming into contact with each other.

When the entire cargo which the vessel carries is oil of a light specific gravity, such as gasoline (petrol) or benzine, additional cargo space for obtaining the maximum deadweight is provided in the wing side tanks, which can be used either for carrying light cargoes or additional oil, in order to bring the vessel down to her normal draft.

Oil Pumping Equipment

The oil pumping installation is one of the most complete ever fitted in an oil tank steamer. There are four oil pumps, two in each pump room. They are of the Worthington duplex type, 12 inches and 22 inches by 11 inches by 18 inches, each capable of discharging 300 tons of oil per hour against a pressure of 200 pounds per square inch.

Two main lines of 10-inch oil pipes are fitted, one on each side of the longitudinal bulkhead. At each tank are fitted 8-inch suctions, together with an 8-inch crossover suction into the adjacent tank on the port or starboard side. These valves are all actuated by wrought iron rods, which are led up to and worked through stuffing boxes on the shelter deck; thus, in the event of one pipe line breaking down, the other main line can discharge oil from both port and starboard tanks simultaneously. There are, in all, 56 suction valves on the main cargo pipe lines. When all four pumps are working the entire oil cargo can be pumped out from the tanks in approximately 18 to 20 hours, while if only one main line of pipe is in use the time taken is about 36 to 40 hours. All the pumps are interchangeable, so that any pump in either pump room can be utilized for pumping through either of the main pipe lines.

Crossover pipes are also fitted between the two main oil pipe lines in Nos. 1 and 12 holds, which are controlled by master valves operated from the shelter deck. By this arrangement, therefore, oil can be transferred from any one tank to another. As already mentioned, the suction valves are actuated from the shelter deck only, but the transferring valves on the main pipe lines are operated from either pump room and are under the control only of the pump room engineers.

Ballast Pump Room Fitted Forward

A ballast pump room is fitted forward, and there is a complete installation of piping for dealing with oil fuel or water ballast in the deep tank and fore peak and forward oil fuel cross bunker.

In the *San Fernando* an indicator and name plate are fitted at each stuffing box on the shelter deck, which indicates when the valve is open or closed. It is therefore an easy matter for the engineer when loading or discharging oil from any one tank to another, or overboard, to open the particular valves he requires for this work before opening his transferring valves in the pump room.

The cargo oil can be discharged either through 8-inch discharge pipes on deck into barges, or alternatively through 8-inch discharge pipes over the stern. The crossover discharge pipes are fitted on the shelter deck at both pump rooms, there being a total of six on each side of the vessel, exclusive of the stern discharges. The advantage of this large number of discharging pipes is that at least four different kinds of oil can be discharged simultaneously through the various pipes without coming into contact with each other.

As very heavy oils are now being carried as cargo, it has been found necessary to fit cargo-heating pipes in order to facilitate the pumping out of this oil, as in some cases it is necessary to heat heavy oil to at least 100 degrees in order to obtain a satisfactory flow through the pipes. Steam is passed through 2-inch coiled pipes, which are laid in the bottom of the cargo tanks. The pipes are of wrought iron ¼-inch thick, with hydraulic joints, and are water tested to 300 pounds per square inch. Steam is passed to these pipes direct from the boiler, the pressure being reduced to 120 pounds by means of a reducing valve. The exhaust steam, after passing through these coils, is led back through a special exhaust pipe on deck to an exhaust tank in the engine room.

Vapor pipes are fitted to the main cargo tanks exhausting into a 5-inch main pipe, which is led 30 feet up each mast. The wing tanks are also fitted with short vapor pipes.

A fore and aft gangway is fitted from the ballast pump room forward to the poop deck aft, on the underside of which is hung on wrought iron hangers all deck steam pipes, wash-deck pipes, vapor, man-exhaust pipe, cargo steam heating pipes, cabin-heating steam and exhaust pipes, pipes for electric cables, telemotor pipes, dock and engine telegraph pipes.

Accommodations

The accommodation provided in the *San Fernando* is very complete for a vessel of this type, each officer being provided with a separate cabin. There are, in addition, on the bridge deck five double berth staterooms for passengers or officials of the company. Separate messrooms

are provided for passengers, officers and engineers. The public rooms, staterooms and lounge are panelled in mahogany. Each cabin is fitted with patent ventilators and fans, and all sidelights and ventilator openings are provided with mosquito screens. A complete installation of steam heating is also fitted in all accommodations. The officers are berthed in the midship deckhouse, the engineers and crew being quartered in the deck house aft, alongside the engine casing. A comfortable smoking room is fitted in the upper bridge deck house, and accommodations for four apprentices are provided.

The refrigerating chamber, cooled by a refrigerating plant of the carbonic anhydride type, is fitted aft.

The *San Fernando* is fitted with a complete Marconi wireless installation, the wireless room being on the upper bridge deck, and accommodation for two wireless operators adjoins this cabin. The boat outfit comprises four large lifeboats and two cutters, two lifeboats being fitted on the bridge deck, while the remaining boats are on the poop deck aft, Welin patent davits being fitted for all boats. Two powerful steam capstans are fitted on the shelter deck aft for maneuvering and warping purposes. The patent hand and steam controlled steering gear is fitted in the after shelter between decks and is of the Wilson-Pirrie type, actuated by telemotor from the wheel house. A docking telegraph is also fitted on the poop deck.

Floating Electric Welder

A New Development for New York Harbor Designed, Built and Maintained by the Vulcan Iron Works, Inc.

BY R. ROYAL ROANE*

THERE was never a time in the history of our country when sound and logical industrial organizations were so necessary as today, not only as it applies to the individual industrial unit, but to industry as a whole. The problems of reconstruction and development are many and diversified; more production is absolutely essential in all branches, and the shipping industry of this country is well on its way towards the accomplishment of this end.

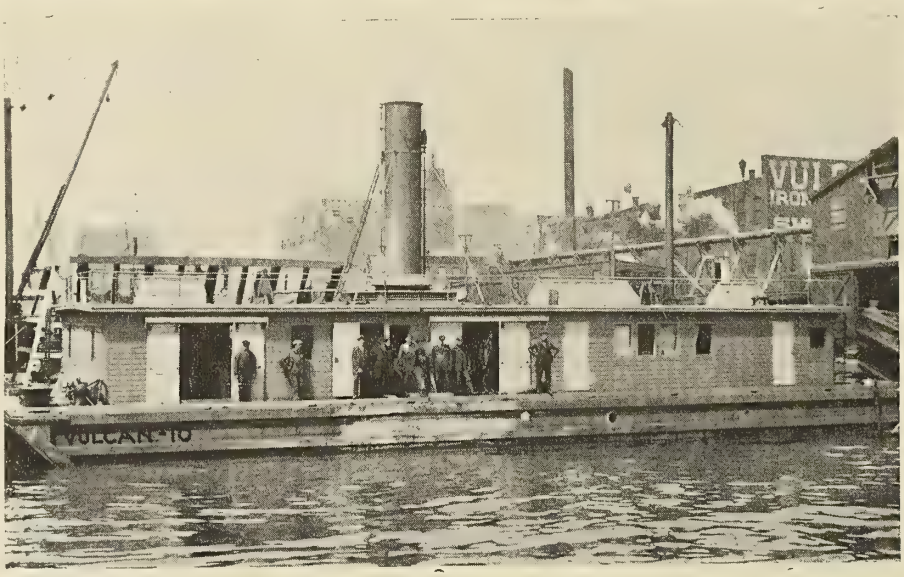


Fig. 1.—Electric Welder Barge *Vulcan-10*

Never previous to the war has such an interest been taken in New York harbor in the problem of floating electric welders as at the present time, and while this is to a certain extent due largely to the volume of Emergency Fleet Corporation ship and boiler repair work, it is essentially an outcome of the normal process of evolution. There are now very few, if any, marine engineers and shipbuilders in this country (especially those doing repair work) who are not thoroughly convinced that a floating electric welder barge is a prime requisite to their organization.

The most interesting feature of this development from the standpoint of the marine engineer is, perhaps, that almost every firm of note is producing or maintaining some kind of electric welding plant, either stationary or floating, to take care of its large volume of repair work.

It is a well known fact that during the recent war the demand for ships and more ships was the paramount consideration, and all branches of the engineering profession and mechanical trades were brought into the work, which quite naturally (due to the inexperience and forced production) meant inefficiency in workmanship, which necessitated numerous repairs to ships, hulls and boilers in order to get them ready for sea duty, all of which met the emergency admirably.

Practically all of these ships in service during the war were forced to the limit of their capacity, and no time was allowed for overhauling and repairs, which are extremely necessary in ship operation; consequently, when the armistice was signed and service reduced, the ships came in by the dozens and hundreds, and all repair yards were flooded with work. Many ships unable to find berths were repaired while lying at anchor in the harbor.

This development of industry as a unit and as a whole is much more of an engineering problem than will be apparent on first analysis. Engineering knowledge properly co-ordinated and adroitly manipulated is the foundation of our industrial structure. The engineering mind, trained in the use of facts and thinking in terms of cause and effect, is the mind best fitted to solve the complex problems confronting modern industrialism.

The shipping industry of this country is a large one, and increased production naturally means more maintenance and repairs. With this end in view, designers and engineers were prompted to develop a floating electric welder barge of this particular class.

* Chief engineer, Vulcan Iron Works, Inc., Jersey City, N. J.

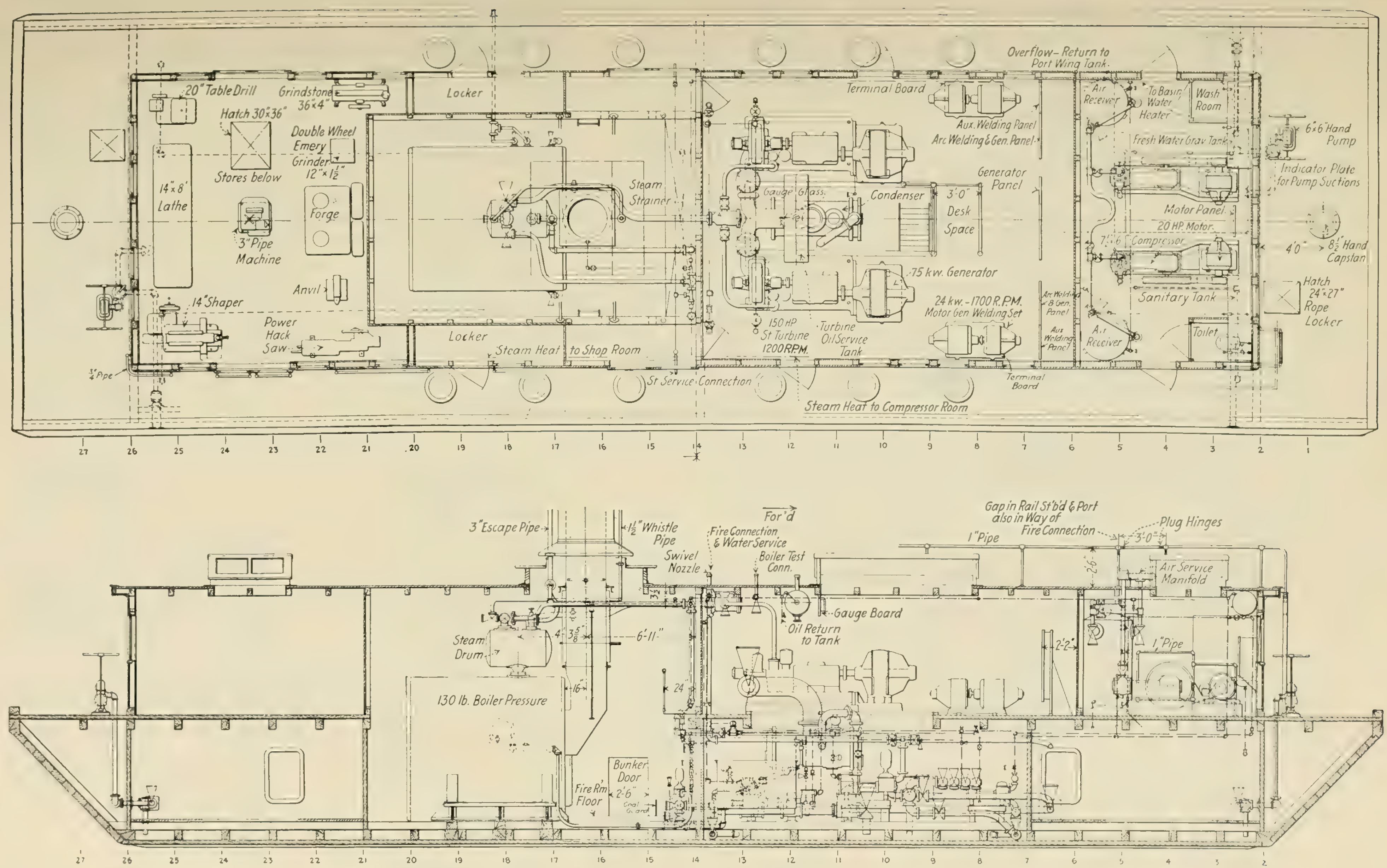


Fig. 2.—Plan and Longitudinal Section of Electric Welder Barge *Vulcan-10*: Length Overall, 87 Feet; Breadth, 26 Feet; Depth, 8 Feet

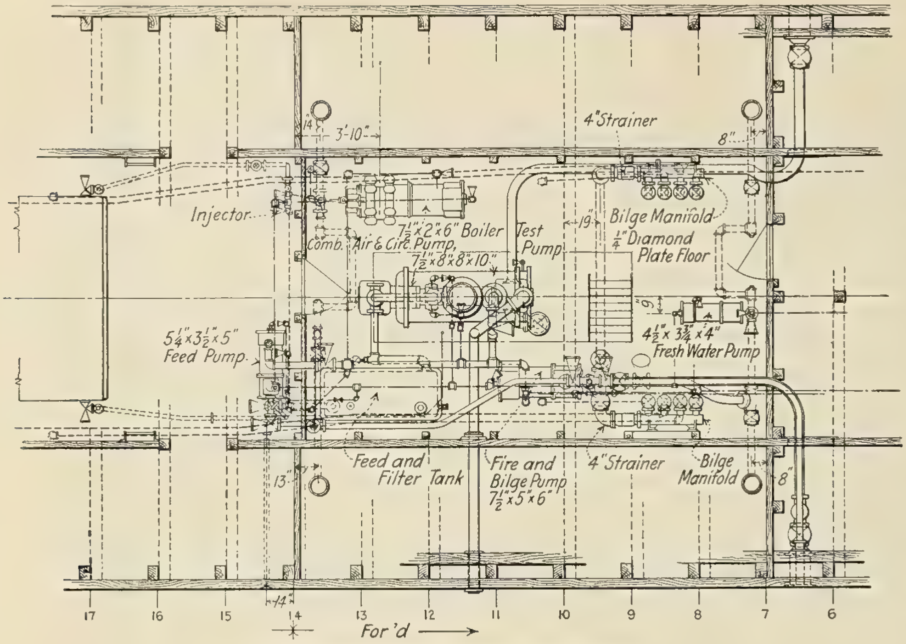


Fig. 3.—Sectional Plan of Pump Room

This particular development has many advantages for repairing ships and doing boiler work while the ship is at anchor. The barge can be towed to the ship and lashed alongside and remain at work night and day, the barge having fuel and fresh water capacity sufficient for an intermittent service of ten consecutive days; if necessary, the men may be berthed and messed aboard the ship they are working on along with the ship's crew.

The hull of this welder as shown on the accompanying plans is built of timber construction, long leaf yellow pine, of the following dimensions:

Length overall........87 feet
Length on bottom.....73 feet
Rake at ends.......... 7 feet
General outside plank..26 feet
Depth including deck and bottom planking. 8 feet
Load draft .... 4 feet 2 inches
Camber of deck....... 2 inches
Built straight with no sheer.

The deck house has a length of 71 feet 8 inches and a width over plank of 18 feet 8 inches. The height at the sides is 8 feet, the camber of roof 2 inches. The projection of the roof eaves over the house, all around, is 12 inches.

This welder carries a Scotch marine single-end type boiler, 9 feet in diameter, 10 feet long, with a steam drum on top, equipped and built to the requirements of the United States steamboat inspectors, with two Morison corrugated furnaces and 3-inch steel tubes. The boiler has a combined heating surface of 1,075 square feet, a grate area of 33½ square feet, and is equipped for burning coal under natural draft conditions.

The main units of this barge will consist of two 75-kilowatt, 100-horsepower, turbo-driven generating sets with DeLaval geared turbines and General Electric direct-

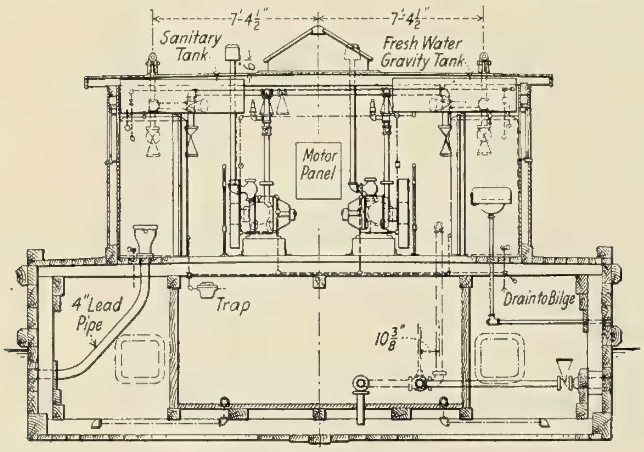


Fig. 4.—Section at Frame 2

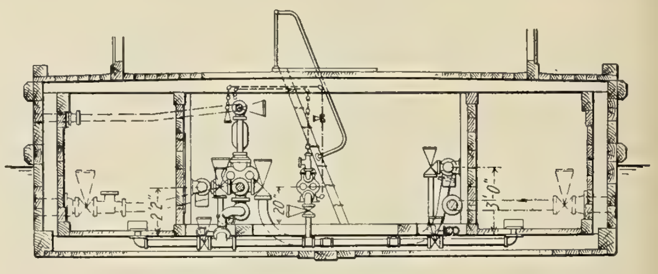


Fig. 5.—Section at Frame 7

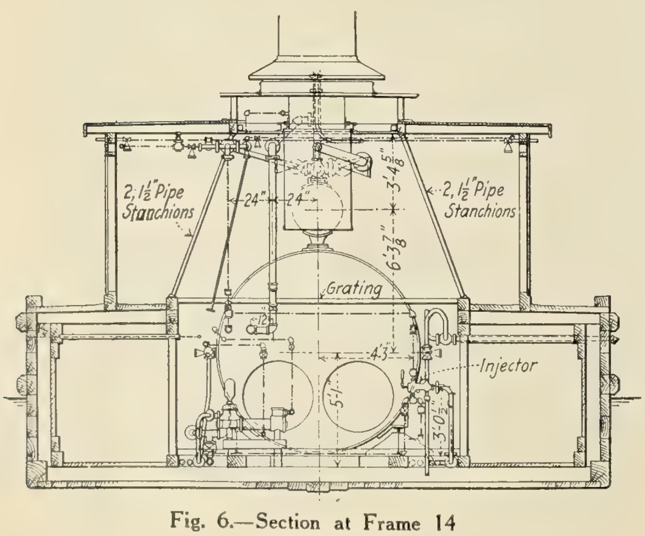


Fig. 6.—Section at Frame 14

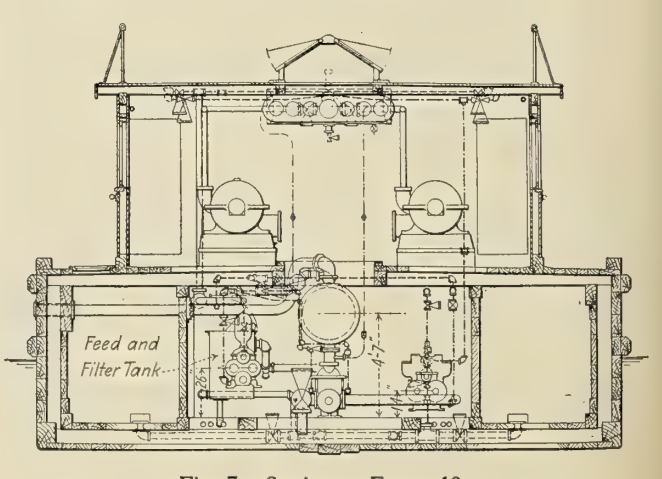


Fig. 7.—Section at Frame 10

current generators for 125 volts, with a steam consumption of 23 pounds per brake horsepower hour. These sets can be worked either singly or in parallel. They exhaust into a surface condenser having a cooling surface of 500 square feet, mounted on a combined air and circulating pump. The pump room carries a boiler feed pump, injector, feed and filter tank, general service and bilge pump, fresh water pump and a 700-pound test pump for testing boilers.

ELECTRIC WELDING UNIT

The electric welding unit is to consist of two 400-ampere, constant potential arc welding sets of the General Electric make, consisting of a 24-kilowatt, 60/60, 1,700 revolutions per minute, compound-wound generator, all mounted on a common base and direct-connected with one 40-horsepower, 125-volt, direct-current motor, all complete with the main control panel and the usual fixtures, one auxiliary panel, starting rheostats, instruments, etc.

Each set is designed to operate two 200-ampere metallic electrode circuits with connections on both sides of the barge, with sufficient wiring for distribution to any part of the ship.

A general switchboard is provided with all necessary fixtures for the accommodation of electric lights aboard the barge, with junction boxes on each side of the barge to supply the ship undergoing repairs either with electric current direct to their main circuit or with portable lights sufficient to do repair work.

The barge is equipped with storage space for carrying oxy-acetylene welders and burners to cover welding repairs where the acetylene flame work is necessary.

One section of this barge is equipped with an air compressor room, with two 100-foot, free air Laidlaw motor-driven compressors, with two large air receivers cross-connected for air service on both sides of vessel. This compressed air is provided for the use of all air tools in connection with repair work of any description.

FULLY EQUIPPED MACHINE SHOP PROVIDED

At the after section of the deck house is located a fully equipped machine shop with the following tools: Engine lathe, vertical table drill, crank shaper, pipe-threading machine, power hack saw, double forge and anvil, and tool grinder and grindstone, all of which are direct-connected with 125-volt, direct-current, variable speed motors.

The demand for this particular class of floating welder barge is very great, in all probability due to its very wide scope of work. In many cases it is not only a question of making repairs to leaky butt straps or joints on the boilers, but it often becomes necessary to replace staybolts, which makes necessary the hack saw, drill press, lathe and air tools, and the replacing, grinding and fitting of new valves, new rivets, overhauling berths, lockers, quarters in general, new calking, testing and a general line of repairs, all of which require a full equipment of machine shop facilities.

The accompanying plans show the general layout of the hull and installation of machinery and piping, which will give an idea of the full design and construction of this particular unit.

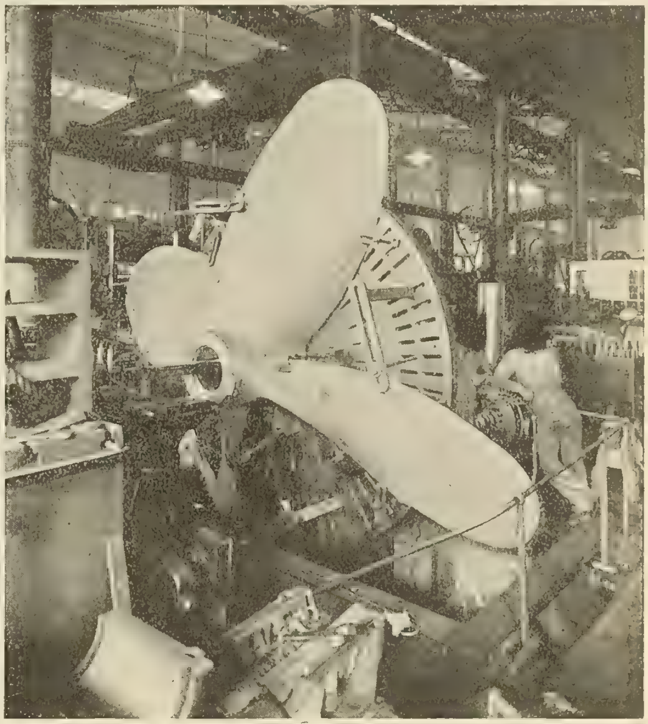
The deck is equipped on each end with a handy billy pump for emergency bilge and fire service, hand capstans, towing bitts, fire hose connections, steam hose connections and air hose connections.

The general layout is roomy, with plenty of windows and skylights, which means air, daylight and sunshine. Modern plumbing facilities are provided aboard the barge for the convenience of the crew.

An Unusual Propeller Job

THE illustration shows an 18-foot diameter, four-bladed, bronze propeller cast in one piece and weighing 22,420 pounds, being bored on the pit lathe at the Union plant of the Bethlehem Shipbuilding Corporation. This propeller was cast at the Union plant for the Moore Shipbuilding Company to be used on the steamship *Howick Hall,* now being repaired at Moore's yard.

It will be noticed in the picture that the tool rest is supported by a swivel stand, so that the guides can be set at the taper required for the hole to be bored. The feed of the tool into the hole is worked by a small independent motor and screw gearing.



18-Foot Diameter Bronze Propeller, S. S. *Howick Hall*

It is a rather unusual practice for a propeller of this size to be cast in one piece, and the capacity for this kind of work at the Union plant of the Bethlehem Shipbuilding Corporation is a great asset to shipping facilities in San Francisco harbor. In fact, it is doubtful whether anywhere else on the Pacific coast this work could have been undertaken without some special machinery being set up or built for the job.

Harbor and Waterway Projects Urged

A resolution adopted by the United States Chamber of Commerce at its eighth annual meeting at Atlantic City calls upon Congress to make appropriations ample for improvement and maintenance of commercially meritorious harbor, river-channel and canal projects. The resolution reads:

"Waterways afford opportunities for increasing the facilities of transportation available to our industries and commerce. Immediate needs for movement of fuel, materials and products require that Congress should at once make appropriations ample for improvement and maintenance of commercially meritorious harbor, river-channel and canal projects which it has approved and which have the interrelation with one another or with other means of transportation that is essential for routes of traffic."

British Battle Cruiser Hood*

Original Design and Later Improvements—Additional Protection Provided—Propelling and Auxiliary Machinery—Comparison With Pre-War Dreadnoughts

BY SIR EUSTACE D'EYNCOURT, K.C.B.

INSTRUCTIONS to prepare designs of battle cruisers embodying the latest ideas in regard to underwater protection, speed, etc., were issued by the Admiralty in 1915. A considerable number of designs were submitted to the Board, but as there were no large berths available, it was not possible to place an order before the spring of 1916, and in March of that year the Board selected a design of the dimensions given below to be worked out in detail. This design formed the original basis for the design of the *Hood*, having the same length and breadth as the *Hood*, but of considerably less draft, viz., 25 feet 6 inches normal and 29 feet deep, with a displacement of 36,300 tons on a length of 810 feet between perpendiculars. The speed was to be 32 knots, with machinery of 144,000 shaft horsepower. The armor, which was approximately equivalent to that of *Tiger*, consisted of an 8-inch belt and 9-inch barbettes. The armament was to be eight 15-inch guns and sixteen 5½-inch guns, together with two 21-inch submerged torpedo tubes.

First Capital Ship Fitted with Small-Tube Boilers

I strongly advocated the adoption in this design of small-tube boilers, and these were accordingly included for the first time in the design of a capital ship. This feature had the most marked influence on the whole design, on account both of the smaller space occupied and the reduced weight involved, as compared with the space and weight which would be necessary for the large-tube boilers which had hitherto been adopted in all our big ships, including the *Renown* and *Repulse*. The first big ships, though they cannot be regarded as capital ships, as mentioned above, which had the small-tube boilers were the *Courageous, Glorious* and *Furious*.

The original design of *Hood* was approved by the Board in April, 1916, and orders were placed to build one ship each with Messrs. John Brown, Messrs. Cammell Laird, and the Fairfield Company, the ships being named respectively *Hood, Howe* and *Rodney*. Subsequently an order for a fourth ship, H.M.S. *Anson*, was placed with Messrs. Armstrong.

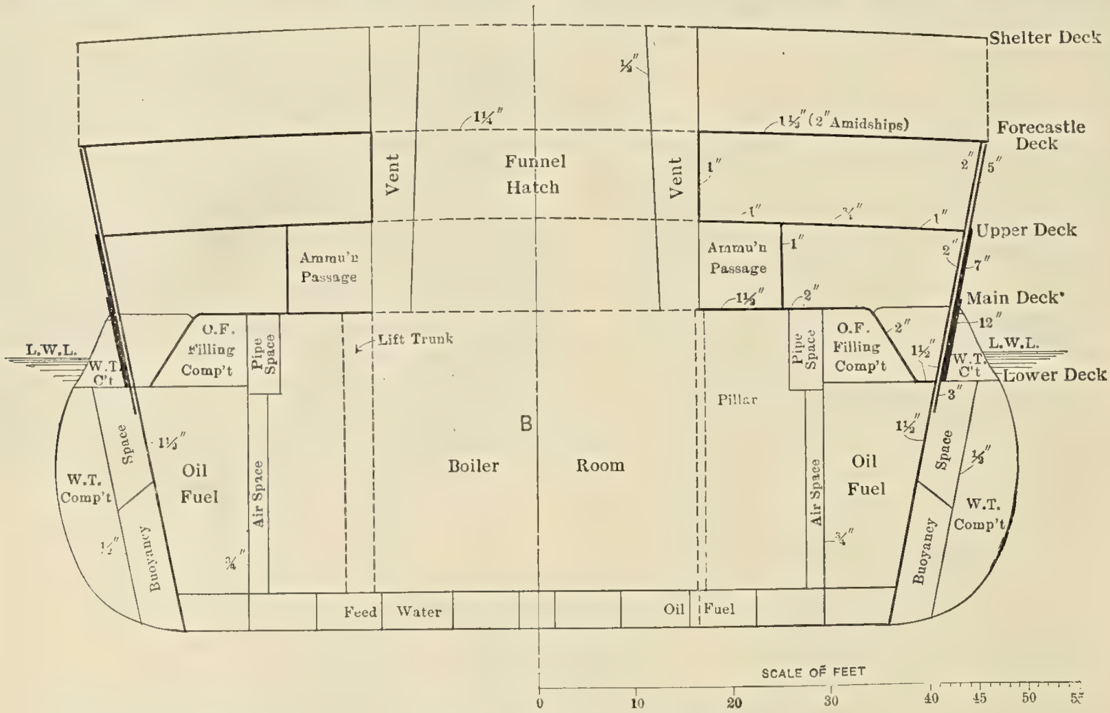


Fig. 1.—Section Through Middle Boiler Room

It will be remembered that the battle of Jutland took place on May 31, 1916. This, the greatest fleet engagement of modern times, naturally led to further consideration of the design of the *Hood*, which had only just been ordered; and, in view of the damage which was done to our own battle cruisers and also to the German ships of similar type, it was deemed advisable to increase the armor protection if possible. As the result of very extensive investigations, it was found possible, by accepting a deeper draft and a slightly reduced speed, to add very considerably to the protection of the vessels as already designed, without serious modification to the design of the ship as a whole. Accordingly, in September, 1916, definite proposals for increased protection were submitted. The alterations were of a very radical character, the armor belt being increased from 8 to 12 inches and the barbettes from 9 to 12 inches, and certain increases were also made in the deck protection. The particulars as thus finally decided are given in Table I. At the same time the eight 15-inch gun mountings had their design modified to admit

* From a paper read before the Institution of Naval Architects, London, March 24, 1920.

BRITISH BATTLE CRUISER HOOD

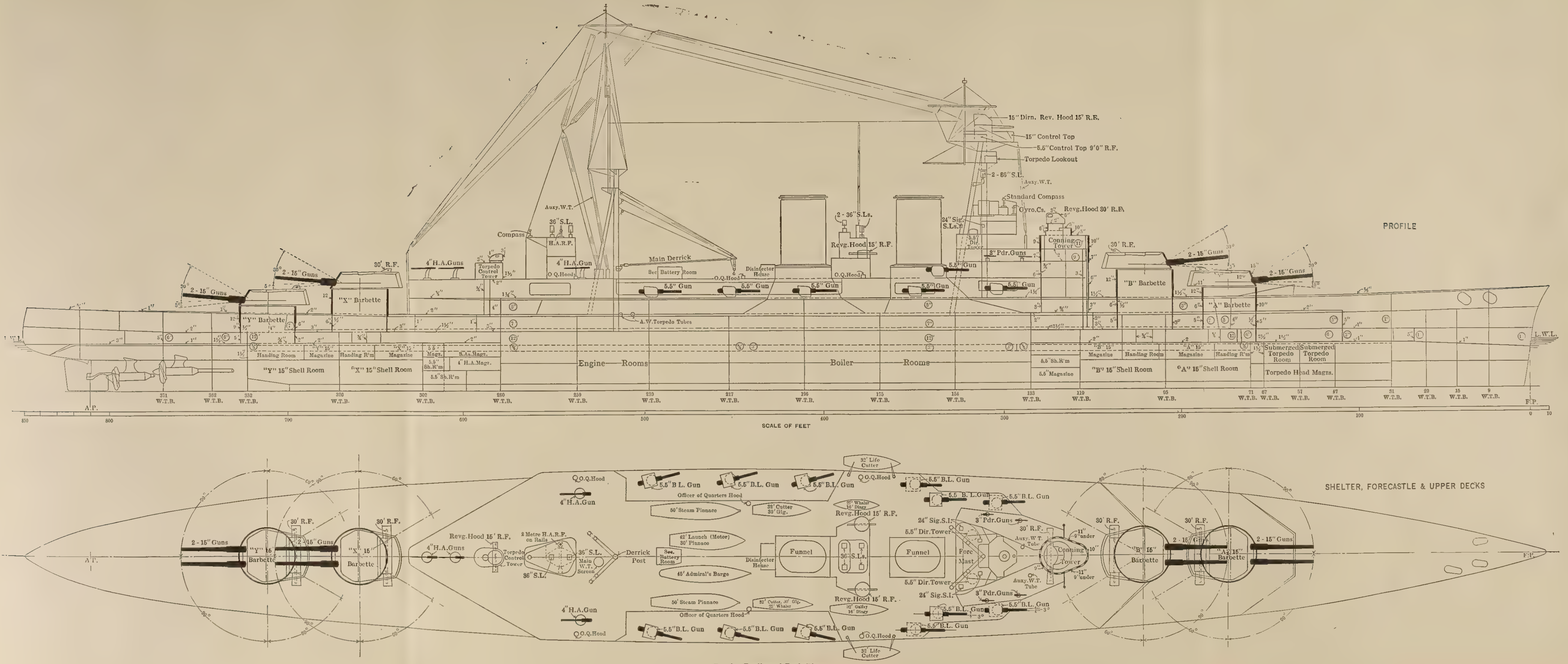


Fig. 2.—Profile and Deck Plans

of an elevation of 30 degrees, and certain other modifications were made both in the torpedo armament and also in the arrangements for preventing the flash penetrating to the magazines—a form of protection which was elaborated for all our ships at this time. All these increases involved an additional weight of nearly 5,000 tons, the legend displacement of the *Hood* becoming finally 41,200 tons when carrying 1,200 tons of fuel, the ship then having a draft of 28½ feet and a draft of 31½ feet with full fuel load, viz., 4,000 tons.

The original length and beam of the ship were maintained as before. Some extra plating had to be provided on the decks for strength purposes, but the underwater protection against torpedoes, which had proved very efficient, was retained, as in the original design. I should mention also that the stability conditions were such that the increased displacement could be accepted while still maintaining a very satisfactory metacentric height.

All the modifications made in the design after the battle of Jutland were considered in consultation, not only with the Board of Admiralty, but with the Commander-in-Chief, involving, as they did, special arrangements for the fire and torpedo control, arrangement of bridges, etc., and it was not untill 1917 that the design was finally approved in all its details. This change naturally militated against the quick construction of the ship, and it will be about four years from the approval of the original design in April, 1916, to the time of her completion, this being about double the time taken to build our recent capital ships, and nearly three times that taken to build H.M.S. *Repulse* and *Renown*. It is only fair, however, to say that the modifications were quite justified by the circumstances, and they have no doubt made the ship a much more powerfully protected one, while increasing her displacement, and consequently the weight of material to be worked, to about 50 percent more than that of *Repulse* and *Renown*.

Propelling Machinery

The main machinery, consisting of geared turbines to develop 144,000 horsepower, is the largest power which has ever been put through gearing, namely, 36,000 horsepower on each of the four shafts. The machinery is placed in three engine rooms, of which the forward one contains two independent sets for the outer shafts, the middle and after engine rooms containing one independent set for each of the inner shafts. This power, which was designed to give 32 knots for the earlier design of 36,300 tons displacement, is expected to give at least 31 knots in deep water at a displacement of 41,200 tons for the *Hood* as built. At the extreme deep load draft of about 31½ feet, a speed of between 30 and 30½ knots should, I think, be realized.

The revolutions per minute of the propellers are to be 210 at full speed, and this admits of the adoption of propellers of higher efficiency than many we have had in our capital ships before gearing was introduced, when the revolutions were considerably higher. A good performance may, therefore, be confidently looked for on the speed trials of *Hood*.

The boilers, twenty-four in number, as mentioned above, are of the small-tube type with forced draft and are arranged in four boiler rooms. It was known that a great number of the later German capital ships took advantage of the reduced weight and space occupied by small-tube boilers and have generally adopted them in their recent designs. It is hardly necessary to say that oil is the only fuel used in *Hood*.

TABLE 1.—LEADING PARTICULARS OF H.M.S. *HOOD*

Length between perpendiculars....	810 feet
Length overall	860 feet
Breadth, extreme	104 feet
Load draft (load waterline), mean.	28 feet 6 inches
Displacement at load draft.........	41,200 tons
Shaft horsepower of engines......	144,000
Speed at load draft..............	31 knots
Oil fuel at load draft............	1,200 tons
Oil fuel capacity................	4,000 tons
Armament	8 15-inch B.L. 12 5.5-inch B.L. 4 4-inch H.A. 2 21-inch T.T. submerged 2 double 21-inch T.T. above water
Armor—	
Side—Amidships	12 inches, 7 inches, 5 inches
Side—Forward	6 inches, 5 inches
Side—Aft	6 inches
Bulkheads, Forward and Aft.....	5 inches, 4 inches
Barbettes	12 inches
Gunhouses	15 inches, 11 inches
Conning tower	11 inches, 9 inches
Protection—	
Vertical plating, magazines, etc...	1½ inches
Forecastle deck, amidships.......	2 inches
Upper deck, amidships..........	1 inch
Main deck	1½ inches flat and 2 inches slope, increased to 3 inches over magazines
Lower deck forward...........	1 inch, 1½ inches
Lower deck aft................	1 inch, 3 inches

WEIGHTS EXPRESSED AS PERCENTAGES OF DISPLACEMENT AT LOAD DRAFT

Item	Percent
Equipment	2.0
Armament	12.5
Machinery	13.0
Oil fuel	3.0
Armor and protection*..........................	33.5
Hull*	36.0
	100.0

* The plating of the decks and sides is required to be of such thickness for strength that it contributes very materially to protection. The weight of this plating is, however, included in "Hull."

Main Armament

It will be seen from the plan Fig. 2 that the main armament of eight 15-inch guns is mounted, as in our recent battleships of the *Queen Elizabeth* and *Royal Sovereign* classes, in four turrets, all on the centerline. The heights of the axes of the guns above the normal load waterline for each turret, commencing from forward, are 32 feet, 42 feet, 31 feet 9 inches and 21 feet 9 inches. The big guns have very large arcs of training, the forward ones training to 60 degrees abaft the beam, and the after ones to 60 degrees before the beam.

The anti-torpedo boat destroyer armament consists of twelve 5½-inch guns with shields 1 inch thick, these guns being arranged on the forecastle deck and shelter deck as shown. There are also four 4-inch anti-aircraft guns on the shelter deck aft.

There are two 21-inch submerged torpedo tubes, each in a separate compartment forward, and four 21-inch above-water torpedo tubes between the upper and forecastle decks, these above-water tubes being a further addition since the original design was made.

Placement of Armor

The distribution of armor is shown in Fig. 1. The 12-inch belt has a length of 562 feet and a depth of 9 feet 6 inches. Above the main belt is a strake of 7-inch armor to the height of the upper deck, and above that again there is a 5-inch armor between the upper and forecastle decks. The side armor all slopes outward from below, as seen on the section, so that the virtual thicknesses are really somewhat greater, as the shell cannot thus hit the armor normally. There is thick plating behind all the armor, varying from 2 inches over the greater portion to 1½ inches and 1 inch elsewhere.

The gun-shields for the turrets are of improved shape, with rather flatter roof than formerly, and the armor has a thickness of 15 inches in front, 12 inches and 11 inches

on the side, with a thick roof plate. The conning tower arrangements have been very specially considered and arrangements made, in addition to the Admiral's conning tower, for torpedo and 15-inch gun control towers and 5½-inch gun control, revolving hood with range-finder, in addition to the range-finders provided in each turret. There are also smaller range-finders in connection with the different controls.

The torpedo protection consists of the bulge arrangement, with an outer compartment of air and an inner one specially strengthened with the necessary separating bulkheads, etc. This protection extends throughout the whole length of the machinery spaces and magazines, and it can be said that it renders the ship as safe against attack from torpedoes under water as she is against gun attack above water.

Origin of Under-Water Bulge Protection

It is a somewhat curious coincidence that the first series of recent experiments on under-water protection should have begun by a set of trials of torpedo charges against the old *Hood,* of the old *Royal Sovereign* class built in 1893. Developing the lessons learnt from these trials, which took place in the year immediately preceding the war, the bulge protection was first designed and fitted at the commencement of the war in the old cruisers of the *Edgar* type, to which I alluded in my last year's paper. A series of experiments was then made at the request of the Admiralty by the late Professor (afterwards Colonel) Bertram Hopkinson, F.R.S., in conjunction with myself, at first under the auspices of the Royal Society. These experiments, which were made on different scales, gradually working up to the full size, were of the greatest value, and the original protection fitted to the *Edgar* was modified and the details of construction as modified have been largely adopted in the *Hood.* I am glad to have this opportunity of paying special tribute to the work of Professor Hopkinson and to his memory.

It may be noted that no ship provided with the original or the later form of bulge was lost, nor even seriously damaged by torpedo attack during the war, nor was there loss of life in any case, this being chiefly due to the special form of bulge and to its being external to the ship proper. By careful attention to the form the reduction in speed is only that due to the added displacement, amounting in the *Hood* to only a fraction of a knot.

Experience and trials have shown that the *Hood,* as protected, can receive the blows of several torpedoes and still remain in the line without serious loss of speed.

In the design of the *Hood* special consideration had to be given to docking, and she is provided with double internal vertical keels along the centerline, and the docking keels come under the longitudinal bulkheads to support the ship on each side. Arrangements are made to dock the *Hood* in our larger docks, and she has already been docked and prepared for trials at H.M. Dockyard, Rosyth.

The *Hood* was successfully launched in August, 1918, at Clydebank, the ceremony being performed by Lady Hood, widow of Admiral Hood, who lost his life while gallantly leading into action the third battle cruiser squadron at Jutland.

Launching Weight and Girder Strength

The launching weight was about 22,000 tons. As the other three ships of the class which were commenced had none of them reached the launching stage at the time of the armistice, it was subsequently decided not to proceed with them, in view of the international conditions, and the *Howe, Rodney* and *Anson* were accordingly scrapped.

The general strength of the ship as a girder had to be thoroughly investigated, both the original design and again when the protection and displacement were increased. Assuming the ship among waves equal to her length from crest to crest and one-twentieth of that length in height (a condition which I do not think is ever likely to be met with) the maximum tensile stress on the top of the girder is less than 10 tons per square inch, and I may add that not one of our recent ships has ever exceeded this amount, although a slightly greater stress has been accepted in some recently designed Atlantic liners. The maximum tensile stress on the keel is less than the above, and the maximum compressive stress does not exceed 9 tons per square inch.

Auxiliary Machinery

The following are some particulars of the general outfit:

Eight dynamos are provided and are widely separated; two are driven by Diesel engines, two by turbo engines, and four by reciprocating engines.

Four hydraulic pumping engines are provided for working the turrets; these and the other more important auxiliary engines are kept well away from the ship's side, as are also the necessary feed tanks.

Pumping and Flooding Arrangements

Special consideration has been given to this item in the design of the ship, electrical bilge pumps have been provided, and also some 100-ton submersible pumps to deal with any water that may enter the ship. For fire and wash deck purposes a fire main is run all fore and aft under protection with rising mains at intervals. This fire main is charged from the 50-ton electrical pumps, and also from the 75-ton steam-driven fire and bilge pumps in the engine and boiler rooms.

In the boiler rooms 1,000-ton turbo pumps are fitted; in each engine room the circulating pumps are arranged to draw from the bilges instead of from the sea, if required. Steam ejectors, each of 300 tons capacity, are provided in the auxiliary machinery compartments and submerged torpedo rooms.

The steering gear is of the right- and left-hand screw type, with connecting rods attached to a crosshead on the rudder head. Two steering engines are placed in the after engine room with shafting led through the shaft passages and thence aft to the steering gear. Auxiliary steering on the Williams-Janney principle worked by electric motor is placed in the after steering compartment.

The main telemotor system is continued aft, so that this gear can be worked from the main steering positions of the ship. The following steering positions are provided: Conning tower, lower conning tower, after engine room, steering compartment (auxiliary only).

Steering by hand power is not provided, as it has proved to be of little value with these very high-speed ships.

The anchors, three in number, each weigh 9½ tons, and the chain cable is of 3⅜-inch diameter. Two cable-holders and a middle-line capstan are provided, all connected to the capstan engine. A third cable-holder is provided for the sheet cable for letting go only. At the stern a 3-ton anchor is provided, and the after capstan is worked by Williams-Janney gear driven by an electric motor.

Special attention has been paid in our more recent ships, and perhaps more than any in H.M.S. *Hood,* to the system of ventilation, which has been worked out on the latest and most scientific principles, a great deal of experimental and research work having been done to get the best results. The main points to be noted are as follows:

The engine rooms are ventilated by four 30-inch and three 40-inch supply fans, and four 35-inch and two 50-inch exhaust fans, electrically driven. Each of the auxiliary machinery compartments has two 17½-inch electrically-driven exhaust fans with "natural" supply trunks, all openings being well above the weather decks, in order that ventilation may go on as usual, even in bad weather—a very important point for the comfort and health of the crew. A very complete system of ventilation has been supplied to the seamen's heads and to all w.c.'s, pantries, sculleries, paint stores, washplaces, etc., the ventilation being general by means of exhaust fans leading direct to the open air. The living spaces generally are ventilated by trunks supplied by electrically-driven fans. These trunks have openings so arranged that the air is delivered at a low velocity, and strong drafts which might be objected to are thus avoided and a gradual supply of fresh air, keeping the whole place sweet, is thus ensured. Where necessary, the air is passed through steam heaters for purposes of warming. In all these arrangements care has been taken to maintain as far as possible the transverse watertight subdivision of the ship, by avoiding the piercing of watertight bulkheads. Each of the main transverse compartments is accordingly ventilated independently of any of the other main compartments, and thus the risk of water finding its way from one compartment to another in case of damage is eliminated.

In all our recent designs, great attention has been paid generally to the accommodation and comfort of the officers and men. Just before the war a special committee was appointed to inquire into the accommodation of ships, and their recommendations have been embodied in the *Hood*.

Boat hoists, fitted with variable speed control gear of the Williams-Janney type, driven by electric motors, are provided, and a weight of 16 tons, that of the heaviest boat, can be lifted and lowered at a rate of 60 feet per minute.

General Design

As regards the general design of the ship, the *Hood* may be cited as an example of what can be achieved by going to a large size. The endeavor has been in her design to embody the armament and armor protection of a first-class battleship, including also good under-water protection against torpedoes, and at the same time to give her the speed of the fastest battle cruisers. It has only been possible to do this by going to a great length and displacement. The under-water bulge protection is additional to anything provided in our pre-war dreadnoughts, although these ships had internal bulkheads. The addition of the bulge, which has entirely superseded the provision of torpedo netting, involved a considerably increased weight over and above that of a ship of ordinary form, and although this additional weight was accompanied by a somewhat greater amount of additional buoyancy, it still involved an increased displacement with the accompanying increase in resistance to propulsion.

It may be argued that in such a large ship a great many eggs are placed in one basket, and that a very expensive one, but it would have been quite impossible to combine the speed, armament and protection in a smaller unit.

In connection with the size of the *Hood* and general considerations of design, it is, I think, interesting to note that of recent capital vessels built, and taking the chief characteristics of two classes of about the same displacement, in *Queen Elizabeth* we had a well-armored ship of about 28,000 tons with eight 15-inch guns and speed of 25 knots. In the *Renown* and *Repulse,* of slightly less displacement, viz., 27,000 tons, though of greater length, we had vessels with 7 knots more speed than *Queen Elizabeth,* but with only six 15-inch guns against eight, and approximately about half the arbor protection provided in the *Queen Elizabeth.* In the *Hood* we are providing the same armament, viz., eight 15-inch guns, as in the *Queen Elizabeth,* armor protection fully equal to, and in fact rather heavier in the aggregate than that of the *Queen Elizabeth,* 6 knots more speed than the *Queen Elizabeth,* which makes the speed nearly equal to that of *Renown* and *Repulse,* and in addition a full bulge protection against torpedo attack.

American Battle Cruisers Modified

It is of interest to note that the American battle cruisers, which were originally designed with very light armor protection, have recently been modified in the direction of additional protection, making them thus more like the *Hood,* and in the annual report of the chief of the Bureau of Construction and Repair for the fiscal year 1919, he says: "On June 24, 1919, the General Board recommended that battle cruisers be built as a distinct type, but the designs be changed to provide materially greater protection against gunfire and under-water attack, the resulting increase in displacement and reduction of speed, probably less than 2 knots, being accepted." This was approved, and the new plans necessary were got out. It is, I think, satisfactory that the American authorities, who have had full knowledge of what we have been doing in this country in the design and construction of warships, should have thus come to the conclusion that we were on the right lines, and have modified their designs accordingly.

As regards cost, which is about 6 millions, this, of course, is an enormous sum, but when the displacement and size of the ship and her qualities are considered, I do not think it is very excessive, in view of the present increase in prices. Most things have doubled in cost, and many of our pre-war capital ships, complete with their armaments, etc., cost on the average about $440 (£90) a ton of displacement. The *Hood* is costing about $707 (£145) per ton, or an increase of only 60 percent above pre-war prices, although she has qualities possessed by no earlier capital ship.

Large Submersible Warships Impracticable

A good deal has been written and talked of lately about the surface capital ship being dead and the necessity for submersibles. But with our present knowledge it would be quite impossible to design a submersible ship which on the same displacement and cost had anything like the fighting qualities on the surface which are possessed by the *Hood.* Every ship is a compromise, and if in addition to the ordinary qualities of a battleship she is required to submerge, or even partially submerge, a very considerable percentage of weight has to be added to give her this additional capability of submergence. She becomes still more of a compromise, and the added weight must detract from the fighting qualities of the ship when on the surface, so that whatever is done, other things being equal, the submersible ship must be inferior to a surface ship in an ordinary action. There are many difficulties of details in the design of a submersible battleship which would take too long to go into fully now, and although there is no doubt that submarines are capable of great development, a little thought will make it clear to anybody that if naval warfare is to continue, the surface ship of the line must still hold the field as the principal fighting unit of any great navy. This view is apparently shared by other countries who are developing their navies, and both Japan and the United States are building large capital surface ships.

Notes on the Dimensions of Cargo Steamers*

BY JOHN ANDERSON

In a paper read by the author before the Institution in 1918 on the most suitable sizes and speeds of general cargo steamers, it was indicated that to obtain the best financial results from such steamers, working under unrestricted conditions of draft and of quantity of cargo available, the dimensions, or total capacity of the vessel, should be in some proportion to the ratio of steaming time to total time on service and also to speed of the vessel. The statement was then made that large dimensions coupled with the greatest economy were dependent upon either a relatively long voyage or a rapid system of loading and discharging. The present notes are an extension of the former paper and are intended to indicate the best proportions of depth and breadth for the lengths already obtained under different conditions of loading and length of voyage.

It is known that the cost of a vessel is reduced per ton of deadweight as the $\frac{\text{length}}{\text{depth}}\left(\frac{L}{D}\right)$ ratio is reduced; also, and particularly in low speed vessels, that the power and fuel consumption is reduced per ton of deadweight as the disposal of displacement is increased depthwise. It is therefore obvious that a relatively short and deep vessel would be the most profitable on a long voyage.

A vessel of large displacement might be found proportionately profitable on a relatively short voyage, but such

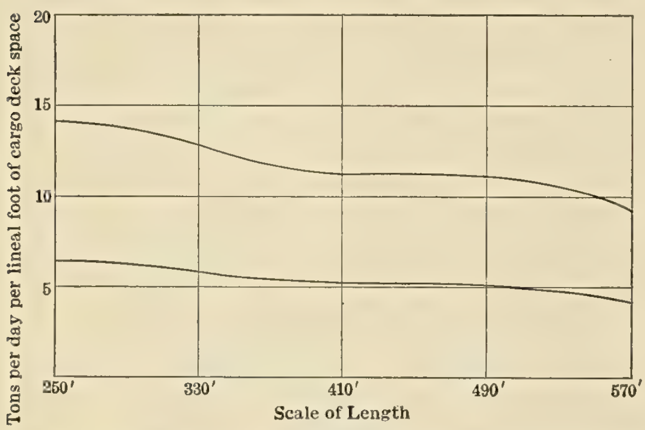


Fig. 1.—To Show the Loading Speed per Lineal Foot of Deck Given by the Derrick Systems Which Were Assumed for the 1918 Paper

a displacement could only be justified by a very rapid "turn round" or cargo handling speed. This factor would be largely influenced, in many cases, and particularly in vessels with slow discharging units, by the lineal fore and aft distance available for working the cargo. It is therefore conceivable that to obtain the best results on a short run for vessels whose time in port is fixed entirely by the time required for loading and discharging cargo it might be found advantageous to sacrifice some of the advantages claimed for deep ships on long runs by disposing the displacement lengthwise, so that additional cargo gear could be arranged per unit of cargo. Such a disposition as this has been practiced in the design of vessels carrying ore on the Great Lakes of America (notably the *Horace S. Wilkinson*, the dimensions of which are 588 feet by 60 feet by 32 feet, which gives a $\frac{L}{D}$ ratio of 18.4), also for vessels engaged on the coastal trades of South America and China.

In order to ascertain the extent to which proportions should be varied for vessels engaged on voyages of varying duration and for different loading speeds, calculations have been made for vessels having what is considered the minimum lengths of erections, i. e., a short poop and forecastle and a bridge covering the machinery casings and the officers' accommodation. Vessels with such erections will probably represent the cheapest type of seaworthy cargo carrier, and will have, at the same time, the maximum amount of flush deck length for the working of cargo.

The results presented in the writer's earlier paper were for vessels of the "well deck" type, having erections covering 50 percent of the length, with $\frac{L}{D}$ ratios of $13\frac{1}{2}$ and with breadths of one-tenth of the length + 12 feet.

Basis of Investigation

The lengths now used are the same as those adopted in the paper referred to, viz., 250 feet, 330 feet, 410 feet, 490 feet and 570 feet, and the corresponding breadths are the same. Alternative ratios for $\frac{L}{D}$ of 11 and 15 are now used, and it is submitted that these combined with the earlier calculations will give the desired information.

With such changes of depth there will be an excess of stability in the case of the shallow vessels, and a deficiency in the case of the deep vessels. On this account additional calculations have been made to show the effect of adopting a breadth of $\frac{L}{10} + 8$ feet for the shallow vessels and a breadth of $\frac{L}{10} + 16$ feet for the deep vessels. These additional calculations have been made for several conditions and are shown on Fig. 3 for speeds of 10 and 14 knots and a voyage of 1,000 nautical miles.

It should be noted that a $\frac{L}{D}$ ratio of 15 is considerably in excess of that allowed by the classification societies for seagoing tonnage with normal scantlings, but, by the courtesy of the chief ship surveyor of Lloyd's Register,

* A paper read before the Institution of Naval Architects, London, March 25, 1920.

it has been possible to ascertain the probable minimum scantlings which might be accepted by that society for future vessels should such proportions be found advantageous.

The calculations have been made for distances of 600, 1,000 and 4,000 nautical miles and for speeds of 10, 12 and 14 knots.

In the earlier paper the time in port was calculated from the number of winches and derrick systems which could be worked at each cargo hatch, and upon assumed working speeds for that type of cargo gear, but as the distance between each ordinary cargo hatch is approximately the same for each size of vessel, it was decided in this case to calculate the time in port as proportional to the lineal feet of deck available for working cargo. By this new process special types of vessels can be dealt with such as those with short hatches through which the cargo is worked by continuous cargo gear. Alternative calculations have been made for loads 6, 12, 20 and 34 tons per lineal foot per day. In order to show how these loads compare with the earlier calculations, Fig. 1 has been prepared, which shows the comparative values given by ordinary derrick gear, and it will be seen that the variation shown for these is produced principally by the H value, which was defined in the earlier paper and is the distance through which the cargo has to be transported. Table I also indicates what the total lifting power per day is under these new assumptions.

TABLE I

Length of Vessel	Total Tons Handled per Day			
	At 6 Tons per Foot	At 12 Tons per Foot	At 20 Tons per Foot	At 34 Tons per Foot
250	780	1,560	2,600	4,420
330	1,175	2,350	3,920	6,650
410	1,560	3,120	5,200	8,840
490	1,890	3,780	6,300	10,700
570	2,190	4,380	7,300	12,400

The variation given by the H value might be taken for all the cargo-handling gear which is generally in use, such as derricks, cranes or grabs. With special appliances such as grain elevators, the "Donald" type of cargo transporter, or other similar appliances which have continuous discharging facilities, a uniform rate per lineal foot such as is now proposed would, however, be most applicable.

The bases used for initial cost, allowances for holidays and repairs, depreciation, fuel consumption, profit, tonnage dues and wages are exactly similar to those used in the earlier paper, and it is assumed that if present-day figures were substituted they would not alter the relation of these factors to each other, but in any case it is submitted that the earlier calculations have shown that moderate variation in any one item will not seriously affect the result which is sought.

Curves for the various conditions have been drawn (and some of these are illustrated on Figs. 2, 3 and 4) giving values respectively for 600 nautical miles and 6 tons per lineal foot, for 1,000 nautical miles and 20 tons per foot, and for 4,000 nautical miles and 6 tons per foot per day.

Results

The final results have been again expressed in terms of "freight rate" for a fixed amount of profit on the invested capital, and of "tons carried per annum" in relation to the initial cost of vessel.

By drawing the appropriate length line for each condition which comes within the limits of 570 feet length, at a position midway between the highest point of the "tons carried" curve and the lowest point of the "freight rate" curve, it is found that for a difference of $\frac{L}{D}$ ratio of 4 there is a difference in appropriate length of about 8 percent at 10 knots and 12 percent at 14 knots, the shallower vessels being the longer. The appropriate lengths given in the earlier paper for a ratio of 13½ can therefore be used and corrected for any required proportion. An increase in breadth has the effect of reducing the appro-

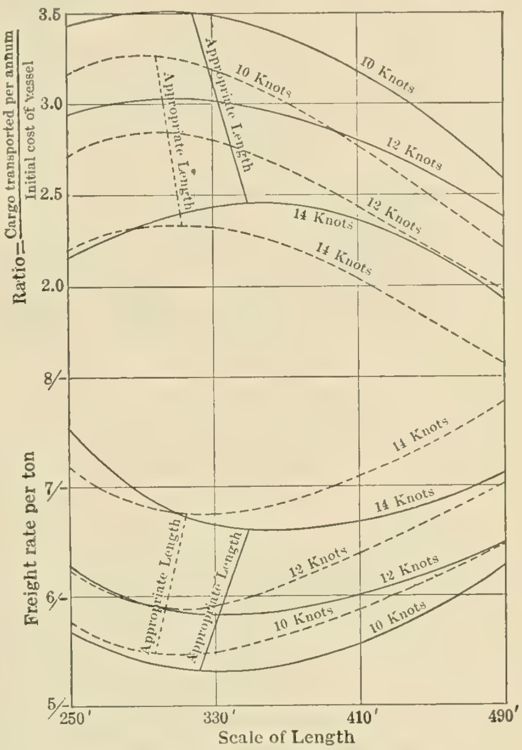


Fig. 2.—600 Nautical Miles and 6 Tons per Lineal Day

priate length, and it would appear that the most suitable size for a vessel could be stated in terms of displacement and speed upon a base of E_t, E_t being the ratio of steaming time to total time.

The calculated results show that for voyages of 600 miles in conjunction with a loading of 30 tons per lineal foot of cargo deck space, 1,000 miles and 21 tons, 1,500 miles and 13 tons or 2,000 miles and 6 tons, the balance is evenly held between low constructive cost per ton of deadweight and low power on one hand, as against the opposing factor of cargo deck space on the other. At these limits the proportions of depth or breadth can be varied widely without making any appreciable difference in the earning qualities.

With an increase of length of voyage or loading speed beyond these limits, the former set of considerations become predominant and a low ratio of $\frac{L}{D}$ associated with increased breadth would give the best results.

As the minimum speed for handling cargo is generally not less than 6 tons per foot of deck space, it would appear that the adoption of extreme proportions should not be considered for voyages of over 2,000 miles.

For voyages of less than 2,000 miles it is found that with loading speeds less than those indicated for the respective lengths of voyage there are slight advantages ob-

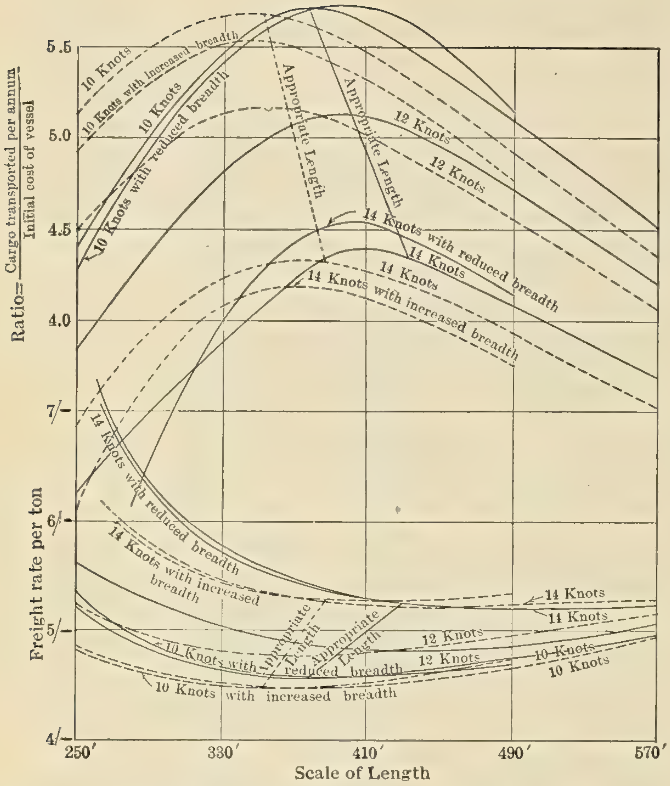


Fig. 3.—1,000 Nautical Miles and 20 Tons per Lineal Foot per Day

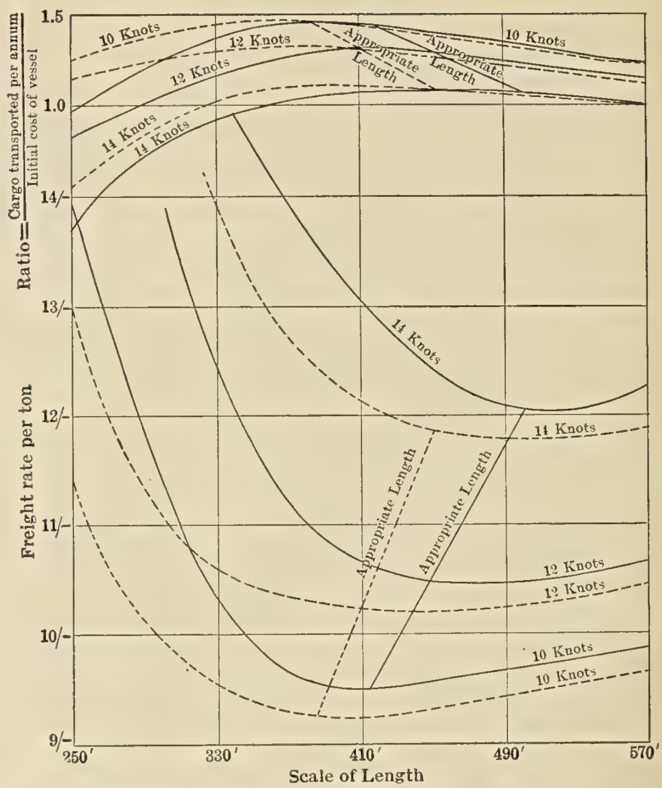


Fig. 4.—4,000 Nautical Miles and 6 Tons per Lineal Foot per Day

tained by adopting extreme proportions or reduced cross-section area, but at the appropriate lengths prescribed these advantages are so slight that no good purpose would be served by adopting such proportions.

If, however, it be found necessary to exceed the appropriate length as defined under these conditions, it may be then found more profitable to reduce the cross section area for vessels which are fitted with slow working cargo gear. If, on the other hand, a length which is less than the appropriate length is decided upon, an increase of cross section area will be advantageous. Figs. 2 and 3 bear out these remarks and show that on the left-hand side of the appropriate length line, increased cross section area will give increased earning power, while on the right-hand side such increases will reduce it.

This statement is borne out by the additional lines which are shown on Fig. 3, to illustrate the effect of modification of breadth.

In giving these results, the writer considers it desirable to repeat that if a vessel is required to make a return voyage in ballast trim, the ballast run should be considered as an extension of the main voyage, and that this consideration will have a bearing upon the proportions to be adopted. Similar remarks may be applied to vessels whose time in port is not fixed entirely by the time required to handle cargo.

It is not conveniently possible to show all the results of the calculations made, but in order to indicate the difference produced by change of proportions and cargo handling speed, Table II has been prepared for loading speeds of 6 and 20 tons, and it gives the values, as a percentage, for a ratio of length to depth of 15 in comparison

TABLE II

To Show the Freight Rates and Tons Carried with an $\frac{L}{D}$ Ratio of 15, in Comparison with Vessels of $\frac{L}{D}$ Ratio 11, the Basis of This Table Being 100 Percent for the Latter Proportion in Each Instance

Condition	10 Knots				14 Knots			
	Loading Speed per Lineal Foot of Cargo Deck Space per Day							
	6 Tons		20 Tons		6 Tons		20 Tons	
	Freight Rate	Tons Carried	Freight Rate	Tons Carried	Freight Rate	Tons Carried	Freight Rate	Tons Carried
600 *Nautical Miles*								
Appropriate length	97	107	99	105	97	104	99	105
85 per cent appropriate length	99	107	100	106	102	100	102	104
115 per cent appropriate length	94	112	96	106	94	114	96	111
1,000 *Nautical Miles*								
Appropriate length	103	101	100	101	97	104	100	104
85 per cent appropriate length	105	98	103	96	106	97	105	94
115 per cent appropriate length	101	103	102	106	92	112	99	105
85 per cent appropriate length and increased beam	—	—	104	99	—	—	106	97
115 per cent appropriate length and reduced beam	—	—	101	106	—	—	98	105
4,000 *Nautical Miles*								
Appropriate length	103	98	109	82	103	99	110	86
15 per cent appropriate length	105	91	109	82	107	90	110	86
115 per cent appropriate length	103	101	109	82	103	101	110	86

with that of 11. The results are given for the appropriate lengths and also for 85 percent and 115 percent of this, and the basis for these figures is 100 percent for a length to depth ratio of 11 in each instance. In the cases of the vessels with altered breadths, the percentages are based on the increased breadth in the short vessels and the normal breadths in the long ones.

It would appear that extreme proportions could not be justified for vessels on voyages of over 2,000 nautical miles unless by restricted depth of water, and if this restriction exists it would be more profitable to increase the breadth than the length beyond normal proportions, provided, however, that such increase did not give an undue excess of stability. Fortunately, extreme proportions would generally be associated with relatively small vessels, and in such it is a comparatively simple matter to add the additional material required to provide the necessary strength. For convenience in calculation the differences have been estimated in terms of length and depth, but it will be understood that when the breadth instead of the depth can be reduced, in vessels with extreme proportions better results will be obtained.

The proportions of the *Horace S. Wilkinson* have already been alluded to, and it is realized that as this vessel is of very special type and construction it may not come within the scope of these calculations. With all the information at hand, it would appear that if the vessel were shortened to about 430 feet and the other dimensions retained, the freight rate might be reduced by about 5 percent. There may be other practical factors which prevail, however, and these remarks should therefore not be taken in a critical sense.

Why is a Progress and Planning Department?

BY DONALD G. STEVENS*

SOMETIME ago the manager of the progress and planning department of a certain eastern shipyard was asked the following questions, not only by heads of other departments with whom he was associated indirectly, but by some of the foremen with whom he was directly interested:

"What does the department stand for? We know you compile a lot of interesting data which you show on attractive charts, and we know there is a considerable amount of work attached to it, but after all what does it amount to? What does it mean to me?"

In reply to these queries the following article appeared in the minutes of the inter-departmental and foremen's meeting:

The function of the progress and planning department is to present to the management a means of control. This is brought about by showing in various ways production as compared with the plan.

This planning covers the keel laying, launching and deliveries of our ships to suit a rate of construction as outlined by the plant manager, and agreed to by the vice-president. To control the progress intelligently planned, important items are used as barometers of the whole, such as rivet drives and erection by hulls, and art shown in chart form in various offices, and on which the actual results are posted each week for the week preceding. In connection with the same thought, and handled in the same manner, are charts showing: (a) total rivet drive; (b) total erection; (c) number of rivet gangs; (d) number of rivets per gang hour and number of men working. There are also tank testing charts for each hull, which show the date the tanks are to be ready for water and when they are planned to be passed, and the dates are posted thereon when same are actually passed. By this method it is clearly shown just how the construction of our hulls compared with the plan, and any deviation is vividly shown.

For the information of the plant manager, the general superintendent and the departments affected, this department keeps up a number of daily charts which show the subdivision of the classes of labor, and are made use of with the idea of properly distributing the work and to eliminate as far possible the day work and to increase the piece work, as this will of necessity cheapen production. These charts are as follows:

(a) Rivets driven per hull per day.

(b) Rivet gangs per hull per day.

(c) Distribution of rivet gangs (whether day work, piece work or agreement).

(d) Rivets per gang hour and cost per rivet.

(e) Departmental charts for bolting, chipping and calking, drilling and reaming (which show number of gangs, day work, piece work, amount of production and cost per unit of day work, piece work and average cost).

(f) Number of night men working.

For the information of the management and all of the individual departments, and graphically shown, are forty departmental charts which show the trend of weekly expense of each department as compared with the entire yard, and which also show the average hour-day rate except when the unit cost can possibly be shown. By such a comparison it is clearly shown just where the increase or decrease occurs, and by study of each department shown it is possible to determine whether the conditions are justifiable and leading towards efficient shipbuilding.

Other miscellaneous charts which deal with our plant as a whole and which reflect our physical condition are:

(a) Weekly commitments and average to date.

(b) Monthly cost per deadweight ton.

In regard to the above work it might be added that there are 145 charts kept up by the progress department which are divided in various proportions in twelve offices (the forty departmental charts not included).

In addition to this the department makes up the following weekly reports: Productive cost report, E. F. C. rivet report, E. F. C. steel situation.

The production cost report is a summary of the week's production and costs per unit, and shows in a comparative way the progress of our yard.

Other miscellaneous work is the determining the percent complete of our hulls on the first and fifteenth of each month, and by which the cost per deadweight ton is figured; the weekly forecast of production for the plant manager, and other work of the above description.

The department is now working on a plan to arrive at a unit of production whereby the work of all departments may be compared from week to week and with one another.

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Freeboard and Strength of Ships*

An Examination of the Existing Rules and Practices of Various Countries Regarding Freeboard and Strength of Ships—Considerations Towards the Establishment of International Rules

BY J. BRUHN, D. SC.

FROM the point of view of the safety of the passengers, crew and cargo, it is of little importance whether a ship founders for want of freeboard, stability, watertight subdivision or strength. It is therefore equally important that a ship should be in possession of a sufficient amount of each of these four qualities. From the point of view of the necessity for government control, their importance is nevertheless in a different position. In practice it has been found that ships are to a sufficient extent assured of having the required amount of stability by leaving it to the shipbuilders to produce a vessel that can be suitably loaded so as to be in possession of the necessary stability and by leaving it to the master of the vessel to see that she is properly loaded.

On the whole, this method of ensuring that ships are in possession of sufficient stability has been satisfactory, and government control has been unnecessary, which is well, as it would be exceedingly difficult to devise a method which would give greater safety than this one, where the responsibility for the stability rests entirely on those who, when the stability is needed, i. e., when the ship is at sea, can alone control the factors governing it. Statutory regulations regarding the stability of ships would also, if they were at all practicable, not be particularly needed, because stability is not a property the increase of which reduces the earning capacity of a ship.

The question of the watertight subdivision of cargo ships has been left to the classification societies and shipowners. Here an increase of safety, i. e., a shortening of the holds, goes against the owners economical interests, and government control may therefore be desirable, and it can in this instance, if found necessary, be applied without difficulty.

Why Freeboard Must Be Controlled

With regard to the question of strength, there is always a temptation for an owner of a ship to try to reduce unduly the amount of structural material in order to increase the deadweight or the earning capacity of the ship. The influence of the shipbuilder and the classification society will, as a rule, be a hindrance to an owner going too far in this respect, but apart from this the temptation to reduce unduly the strength of a ship occurs practically only once, viz., when the ship is being built, and even then in a not very acute form with an immediate economical gain in sight. It is quite otherwise with regard to the loading of a ship. An owner has here always a much greater temptation to go too far than in the case of the strength. The draft can, after the vessel is built, easily be increased for the particular voyage or from time to time as competition may indicate the desirability of such a proceeding, until the safe limit is ultimately exceeded. There is therefore much greater need of government control with the freeboard of ships than with stability, subdivision or strength.

It was only natural when a classification society (Lloyd's Register) first proposed rules for the freeboard of ships that the rules were arranged to fit in the most convenient manner the types of vessels then provided for in the society's classification rules. In that way it came about that the first complete freeboard rules prescribed a larger freeboard for certain types of ships (viz., the awning and spar deck types) than was necessary from a height of platform or spare buoyancy point of view. When the Board of Trade had first to put into force statutory load line regulations, it was also natural that the very complete freeboard rules prepared by Lloyd's Register should be adopted practically without alteration. These first government freeboard rules might, however, very well without any reduction in the general standard of safety have been so arranged that they only prescribed a real minimum freeboard or height of platform for all vessels. If in certain cases (awning and spar deck vessels) the freeboard was larger than that required by the rules, so much the better. For all ordinary types of vessel these freeboard rules left in practice the controlling of the strength to the classification societies. If, in the case of awning and spar deck vessels, the freeboard were larger than prescribed, all that was required would be an arrangement whereby the necessary strength was guaranteed, and if the controlling of the strength were left to the classification societies in the case of all ordinary vessels with the minimum freeboard, there appears to be no good reason why the same control should not also be left to these societies in the case of awning and spar deck vessels, where the only difference between them and the former vessels was that the freeboard was somewhat larger. In other words, there appears to have been no particular necessity for the government to lay down special regulations for the determination of the freeboard of classed spar and awning deck vessels.

The principle of practically leaving the control of the strength of ships to the classification societies in the case of all vessels having the minimum freeboard permitted by the load line regulations and of having certain government regulations for the strength of vessels with larger freeboard has been incorporated from the British rules into the freeboard rules of all other countries, mainly, of course, because the British rules were the older ones and they have therefore served as the pattern for the others, but to a certain extent no doubt also because the various national classification societies, which administer the rules found such an arrangement convenient, as these institutions would otherwise be compelled to have a similar arrangement of their own for dealing with the vessels having a larger freeboard than the minimum permitted by the government rules, just as Lloyd's Register had before there were Board of Trade freeboard rules. The principle is nevertheless not a very rational one. The original idea in Lloyd's Register freeboard rules was that the extent of loading of the various types of vessels such as flush deckers, spar deckers and awning deckers should be in proportion to the strength of their hulls. This idea was, of course, sound enough and could be carried out

* Paper read before the Institution of Naval Architects, London, March 25, 1920.

satisfactorily in practice as long as the assigning body used the same standard of strength for all three types of vessels. The Board of Trade standard (Lloyd's rules of 1885) stood practically unchanged for thirty-five years. During this time experience showed the necessity of making many alterations and additions to the classification rules. The consequence of this has been that the latter rules in many cases call for greater strength than the Board of Trade rules. The classification society's rules were applied to all ordinary full scantling types of vessels (flush deckers, three island vessels, etc.). If these rules had been applied consistently in the same manner to the other types (spar and awning deck vessels), then the original idea that the loading should for all types be in proportion to the strength could have been carried through. It became, however, the practice of the assigning bodies to deal with spar and awning deck vessels (or practically all vessels classed "with freeboard") on the lower Board of Trade strength basis. The result was that the additions which the classification societies in the course of time had made to the scantlings of these vessels to a large extent became illusory as the draft could, in accordance with the government regulations, be increased correspondingly. The standard of strength of these vessels was thus in reality lower than that of the ordinary types of vessels, in the proportion in which the requirements of the 1885 rules were below those of the present rules.

One consequence of this anomaly is the well-known fact that a shelter deck vessel can, according to the Board of Trade regulations, when the tonnage opening is closed, suddenly be immersed two or three feet deeper in the water without any increase of the scantlings, because when there is a tonnage opening such a vessel is dealt with on the basis of the regular classification rules, and when there is no tonnage opening she is dealt with on the lower Board of Trade standard.

The main object of government regulations regarding the strength of ships in connection with the assignment of freeboard ought to be to provide an adequate margin of safety for passengers and crew. This object can hardly be achieved by the regulation proposed by the load line committee. It may, nevertheless, be that the proposal is the best possible for British conditions, taking every circumstance into consideration, but the conditions are different in other countries. My object in reading this paper has been to raise, if possible, a discussion on the subject where the voices from other countries can be heard before a method of dealing with the strength of ships could be established internationally, and I hope my friends on the British load line committee will not take offense at my criticism of this particular point in their report.—*J. Bruhn, D. Sc.*

Freeboard Rules Adaptable for International Use

Freeboard rules in the narrow sense of the term are of the kind which it is particularly desirable should be uniform in all countries, so as to ensure a uniform standard of safety and a fair international basis for competition with regard to carrying capacity, and freeboard rules are at the same time of a nature which makes them comparatively easily adaptable for international use. It is otherwise, however, with the question of strength. An international application of strength regulations is not nearly so necessary as an application of pure load line regulations, and it is not nearly so easy, at least until universal classification rules may be adopted. The proposal of the British load line committee of 1915 is, as regards the rules for the minimum freeboards of vessels, probably the best that could be made as a basis for an international agreement on this point. On the question of the relation of freeboard to strength, the committee seems on the other hand to have been afraid to deviate too much from the established order of things. However much the system may be improved, if a second standard of strength, which must necessarily be a lighter one, is introduced in addition to the classification standard, there will still be anomalies. The committee's proposed method of dealing with the strength question cannot, therefore, in spite of the many improvements in details (as compared with the earlier method), be considered as a very satisfactory one, particularly if it is to be used internationally. There appears in reality to be no very strong reason why detailed regulations regarding the question of strength should not be left out of international freeboard rules. Such regulations cannot under any circumstances provide a guarantee of the safety of a ship in every respect. They ought, and practically can, only provide a statutory security against one particular danger, viz., undue overloading. The question of stability of the vessel is, for instance, necessarily left entirely to the care of the master, and when, from the point of view of safety, so important a property as the stability of the vessel can be left out of consideration in assigning the load line, it would appear that the strength of the vessel might with equal safety be left out of consideration in this connection.

It may, however, be expedient to make some reference in international freeboard rules to the question of strength, as it is no doubt expedient to make some reference to the question of stability such as that proposed by the British load line committee. In the first place it might be made clear that the freeboards prescribed are the absolute minima. Secondly, it might be stated that all vessels allowed to load to these freeboards are to have at least the scantlings required by a recognized classification society. A requirement of this nature would, as regards its results, be in accordance with the present practice in all countries having load line regulations. Thirdly, there might be a regulation to the effect that the standard of strength for all vessels with a higher freeboard than the minimum laid down in the rules shall not be less than that required by the particular assigning society for vessels of the full scantling type. In that way each classification society would have only one minimum standard of strength for all first-class seagoing vessels, and the society itself would be entirely responsible for the upholding of this standard, both for the full scantling types and for the lighter scantling types, whereas by the present practice the classification society is really only responsible for the strength of the full scantling vessels, the strength of the vessels with reduced scantlings being regulated not entirely by the society's own rules, but more or less by the legal load line regulations.

It is very desirable that the strength required for any given draft or freeboard should be clearly laid down. The British load line committee proposes that there shall be provided freeboards for two types of vessels, the flush deck one and the complete structure one. This principle is a very convenient one, and it will no doubt be adopted internationally. In Norway such a practice has, as a matter of fact, been used for a long time. Probably all

classification societies have already got rules for the scantlings of these two types of ships. All that is necessary in order to obtain a regulation ensuring a uniform application of strength requirements for each society would therefore be a statement to the effect that the scantlings for vessels with freeboards falling between that of a flush deck vessel and that of a superstructure vessel are to be obtained by direct interpolation between the scantlings required for the flush deck vessel and the scantlings required for the superstructure vessel. Let S

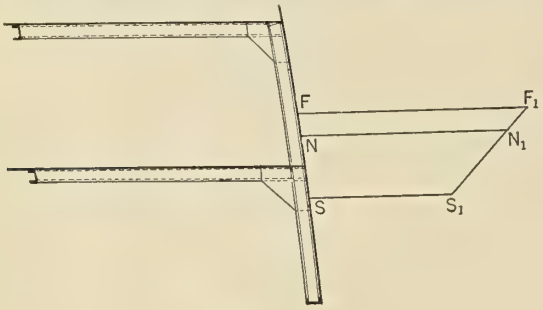


Fig. 1.

and F (Fig. 1) be the respective positions of the load lines for a superstructure and a flush deck vessel and let SS_1 and FF_1 represent the dimensions or numbers which the classification society in question use for the determination of the scantlings of the superstructure and flush deck vessel respectively. For any intermediate position of the load line, say N, the dimension or number regulating the scantlings will then be NN_1. The scantling requirements under such a regulation will therefore be as completely specified for a vessel with an intermediate freeboard as they are for the two standard types, and some such method will probably be necessary if the original idea of uniform strength in proportion to draft is to be carried out in a satisfactory manner in practice. In Norway such a procedure has been established for some time.

British Load Line Committee's Strength Proposals

The method proposed by the British load line committee of dealing with the strength question involves in reality a fixed standard of strength apart from the current classification regulations. It is in this respect no better than the previous method based on the strength standard of 1885. From the manner in which it is arrived at, viz., as a sort of minimum of the minima of the classification requirements, it follows that the standard will, like the previous one, be below the current practice. A vessel may therefore under the proposed method be built with the classification scantlings required for a certain lighter draft and may then, just as under the present regulations, claim to be allowed to load to a deeper draft, viz., that which the proposed government freeboard standard of strength would allow. It may, of course, from a narrow classification society point of view be considered satisfactory to have such an officially recognized standard of strength lying below the classification standard, as it will to a large extent relieve the classification societies of the full responsibility for the strength of the ships they class. In the long run, however, it is better for the classification societies, as well as for all other interested parties, that these institutions should alone have the full responsibility for the sufficiency of the scantlings they prescribe. In time the proposed system might have the effect of pressing the various classification requirements down to a standard for which no one would really have any direct responsibility, a state of affairs which would also be unsatisfactory.

The method which the load line committee recommends for the determination of the required scantlings may be considered quite satisfactory as a naval architect's method of examining many questions regarding the strength of ships. I have myself in two papers read before the Institution of Engineers and Shipbuilders in Scotland in 1902 and 1905 recommended very similar methods for such purposes of comparison. The method is, however, not satisfactory when it is a question of establishing a fixed legal standard of strength, particularly an international one. It is quite clear that such a method cannot take account of all the factors affecting the correct and complete determination of the minimum strength required. It cannot therefore be scientifically right and it would be exceedingly undesirable to fix a method of this kind in a rigid legal form which could not be altered for a long term of years to rectify the faults which would be sure to be discovered in course of time in the same manner as faults have been discovered in the previous load line regulations and as faults are discovered even in the best of classification society's rules. It is quite impossible with such systems to foresee all the conditions which may affect the problem. If a method such as the one proposed by the load line committee were established internationally it would soon be looked upon as a scientifically correct way of estimating the strength of ships, and as it would become unalterable, like the laws of the Medes and Persians, it would come to be a hindrance to progress towards using more correct methods.

Objections to Proposed Methods

From a scientific point of view there may even now be raised several objections in details against the proposed method. It assumes that the moment of resistance principle is sufficiently free from faults to stand as the main basis for strength estimates. This principle is, however, far from correct for so complex a girder as that of a ship's hull, and in the manner in which it is proposed to be applied it ignores, among other things, the component effect of the local straining actions in the same or another plane than the main one. The important bending and buckling tendency of the deck and bottom plating is thus ignored. In determining the moment of resistance for longitudinal strength, the form of the midship section is ignored, with the result that a ship with a high rise of floor would be required to have even thicker plating than one with a flat bottom, which would not be in accordance with the lessons of experience. Two very important factors are also ignored, viz., the nature of the trade the vessel is engaged in and the distribution of weights. At present, classification societies also ignore these factors, but they ought to be taken into account as time and progress make it possible to do so. The Norwegian classsification society and the Norwegian Board of Trade have, as a matter of fact, to a certain extent already taken these factors into consideration. In estimating the transverse strength, the plating is ignored in the determination of the moment of resistance of the frames. This will give very misleading results as to the comparative values of the various forms of frame sections. Channel bars or frames with very heavy reversed bars would thus appear too to be strong compared with bulb angle frames. A number of other more or less important factors are ignored in dealing with the transverse strength, such as the effect of the vessel's breadth, spring, bulkheads, stiffness of bottom and deck construction, the form of the vessel (curvature of frame), effect of size of lower deck beam knees, etc. The stiffness of the ship (metacentric height) is also an important factor when it is a question of de-

termining the proper minimum transverse strength of ships. It does not figure directly in the classification societies' rules for the determination of the scantlings of frames, floors, etc., but it is indirectly there to a certain extent, as the scantlings prescribed for sailing vessels without bulkheads, for instance, very distinctly assure that the stiffness deviates but little from the normal for such vessels, otherwise the strength would in many cases be quite insufficient. There is in the load line committee's proposal no standard of strength at all for the deck (beams) and bottom (floors) of ships, although both these parts are very important—in fact, just as important as the sides of the vessel and, as far as the bottom is concerned, just as closely related to the draft or freeboard of the vessel. The above points are sufficient to show that the proposed system is not scientifically quite satisfactory.

Proposed Method Incomplete

There are also, from a practical point of view, objections to the proposed method of dealing with the question of strength. In reality this method means the establishing of a second system in addition to the classification society systems of determining the scantlings of ships. It is clear that the required scantlings could for the items in question very well be produced by some such method as the one proposed, just as satisfactory scantlings might, owing to the great similarity in the proportions of ships, be produced by many other methods than those adopted by the various classification societies. The question is, therefore, whether the new system is necessary or is a better one than the old one.

It might, from the point of view of public safety, be necessary to introduce a new method, if the previous one did not provide sufficient strength. But the proposed system being a minimum of the present minima leads to less strength than is now required. There can therefore, from the point of view of safety, be no necessity for it. Moreover, if the proposed system were required from the point of view of safety, it ought to be reasonably complete and provide the required strength for all those parts the weakness of which might affect the safety of the ship, in the same manner as the present classification methods do. It is, however, by no means complete. There is thus, as already pointed out, no provision at all for the strength of the bottom or decks nor for the strength longitudinally and transversely at the ends of the vessel. If a ship breaks down for want of strength in the bottom or at the ends, the consequence will of course be very much the same as when she breaks down for the want of longitudinal strength amidships. Again, there is no provision as to what rivet attachment is required for the various parts of a vessel. Experience shows that with the present practice it is usually in the rivet attachments that weakness occurs, and it would therefore, from the point of view of safety, be particularly desirable that a minimum safe basis for the amount of riveting required should be provided. The load line committee does not mention either what is to be done with wood and composite ships, which is particularly regrettable seeing that many ships of this type have lately been built and these would also be in need of strength. Nor are old ships provided for. It may be argued that all these points will be looked after by the assigning bodies, and that, no doubt, is so. In practice all these points must of necessity be looked after by these bodies, and, moreover, the probability is that the same bodies will look after the strength in their own way, even where the proposed load line regulations prescribe scantlings. In fact, the classification societies' requirements would be absolutely necessary in addition to the proposed method, but then the latter could not be a better or even a satisfactory method.

As the classification societies' methods are the more complete, the proposed one would, in fact, be unnecessary. The introduction of another system in addition to the classification societies' system would mean that there would be two systems for the determination of the same thing, viz., the proper scantlings of ships, and this would further mean that shipbuilders and designers would have to work out the scantlings of ships according to both systems, which would involve an unnecessary waste of time. It might be that the classification societies would attempt to draw up their regulations in such a way that their scantlings always came out in excess of those required by the legal regulations. In that case shipbuilders and designers could, when using the classification regulations, be sure that they were on the right side. But the other regulations would then serve no practical purpose.

From the practical application point of view, the proposed principle of only requiring certain moments of resistance and not specifying definite scantlings is unsatisfactory and will, particularly if it should be applied to international practice, cause many questions to be raised as to which form of frame section, thickness of web, width of flanges, etc., should be required.

From the way in which the formulæ proposed by the load line committee are arrived at, they must, as stated above, necessarily lead to insufficient strength. An examination of the scantlings which would be satisfactory according to the proposed method will confirm this. A comparison with the scantlings which experience has shown to be necessary for the trades of Norwegian ships proves also that the proposed strength is, at least in this case, insufficient, and it would therefore be quite indefensible to adopt the proposed standard of strength as the legal standard for Norwegian ships.

Draft as a Factor in Determining Scantlings

Most classification societies have up to the present based their scantling requirements for ordinary ships on the dimensions of the vessel and have ignored the draft in this connection. This is convenient, as the draft is a less definite quantity than, for instance, the depth of a vessel. There is, however, in principle no reason why the draft should not enter into the determination of the scantlings, but it would be most rational that it should do so by being incorporated directly into the particular system used by the assigning body in question, otherwise anomalies cannot be avoided. An example of how such an incorporation may be effected was shown above.

Corrections.—On page 271 of the April issue was shown an illustration of the 100-foot harbor tug *Energy*, which it was stated was built by the Northwest Engineering Works. Although the Northwest Engineering Works built several vessels of this size and type, this particular tug was built by the Leatham & Smith Towing and Wrecking Company, Sturgeon Bay, Wis., and the engines were built by the Marine Iron Works, Chicago.

On page 362 of the April issue in an article on "Standardizing Tackle Blocks," a typograpical error occured in printing the following equation:

$$p = \frac{Q}{Z' \times d} = \frac{14{,}000}{4\frac{7}{8} \times 1\frac{1}{2}} = 7{,}920 \text{ pounds per square inch.}$$

The correct result should read 1,920 pounds per square inch.

The Economic Position of Great Britain as a Shipbuilding Country*

BY SIR ALFRED YARROW, BART.

EVERYONE is asking: "How long will the present shipbuilding boom last, and what will be the situation when it ends?" The answer is: It will last as long as the following two conditions hold: (a) That the world's carrying trade in passengers and cargo needs more tonnage to carry it. (b) That we can supply this tonnage at least as cheaply as our foreign competitors. The first of these two conditions is closely related to the financial and commercial standing of our own and other nations. The second depends upon our general economic position, and especially on the efficiency of our shipbuilding and allied industries.

As shipbuilding and, in fact, all our industries depend in a great measure upon the financial stability of the country, let us consider the country's present liability and how best to meet it. The country's liability is shown in Tables I and II.

TABLE I.—ESTIMATED NATIONAL EXPENDITURE IN 1919-20

National debt services	£360,000,000
Payments to local taxation accounts, etc.	9,763,000
Land settlement	5,000,000
Other consolidated fund services	1,832,000
Army	287,000,000
Navy	149,200,000
Air force	66,500,000
Civil services—	
Public education	38,841,000
Old age pensions	17,892,000
Ministry of Pensions	72,855,000
Insurance, etc.	13,435,000
Civil demobilization and resettlement	30,874,000
Loans to Dominions and Allies	87,500,000
Railway agreements	60,000,000
Bread Subsidy	50,000,000
Other civil services	74,407,000
Add: supplementary estimates to be presented	60,000,000
Customs and excise and inland revenue departments	8,537,000
Post office services	41,274,000
Total	£1,434,910,000

TABLE II.—PRESENT ANNUAL EXPENDITURE

Treasury estimate of the national expenditure for the year 1919-20		£1,434,910,000
To this total we have to add the value of what we import in excess of what we export, the difference being what we owe to the various countries from which our imports come. According to the Board of Trade returns for last year this amounts to	£669,000,000	
From this we are entitled to deduct what are called "Invisible Exports," but which would be better termed "estimated revenue made abroad by British owners and by British shipping and remitted to this country," which is estimated at	520,000,000	
Leaving a balance against this country of		149,000,000
Sinking fund		36,000,000
Grand total estimated expenditure		£1,619,910,000
Estimated revenue, 1919-20		£1,168,650,000
Annual present increase of our indebtedness		£451,260,000
Assuming emigration to foreign countries (excluding our colonies) continues at the same rate as before the war, there will be an annual drain on the country to cover the cost of bringing up those emigrants, estimated at	£40,000,000	
We are still further in debt to the extent of the paper currency issued in excess of the gold in hand, which is approximately	£300,000,000	

To endeavor to arrive at the turning point when our revenue will be equal to our expenditure, it is clearly evident we must reduce all expenses such as naval and military expenditure (estimated by the treasury at £1,434,910,000), which is mainly in the hands of the government; but it rests also with everyone to work hard and to make our exports equal our imports and thus endeavor to blot out the £669,000,000 representing what we are annually purchasing from abroad in excess of what we are sending in part payment, and if possible, ultimately, as in the United States and in many countries, to export more than we import. Unless we supply sufficient manufactured goods to the markets of the world in payment of what we need from abroad, foreigners will decline to supply us with foodstuffs and raw material, or will only do so at very high prices, which will lead to scarcity and to even still higher prices. This is what is taking place at the present time.

The only way to secure for the artisan continuous employment at good wages is for every man to do his best and be paid in proportion to his efficiency, and in this supposed free country we should insist that everyone shall be free to work when and as he chooses. Any method of artificially increasing wages only results in a temporary gain at the sacrifice of the worker's future welfare.

It is a fact that generally where wages are high and the output per man is also high, the cost of production is the lowest, and, in consequence, trade is secured. The reason why high wages, and output in proportion, are advantageous, is that the establishment charges are thus diminished proportionately to output.

If regulations are made restraining our artisans from doing their very best, by insisting on arbitrary lines of demarcation or by reducing output, this increases the cost of production so that the lead in shipbuilding will pass into other hands and a very heavy responsibility will rest upon those who make such regulations.

Competition

The following statistics illustrate the rapid advance in shipbuilding made by the United States and Japan in recent years. Unless we are able to build as cheaply as in these countries, the time will inevitably come when British and foreign shipowners will purchase their ships from foreign builders in the same way that marine engineers in this country prior to the war obtained their shaftings and forgings from Germany.

MERCHANT VESSELS LAUNCHED (IN TONS)

	1913	1919
United Kingdom	1,932,000	1,620,000
United States	276,000	4,075,000
Japan	65,000	612,000

TABLE III.—PRODUCTION OF MILD STEEL (IN TONS)

Year	Great Britain	Germany and Luxemburg
1873	588,000	310,000
1883	2,041,000	859,000
1893	2,983,000	2,231,000
1903	5,113,000	8,669,000
1913	7,663,000	18,958,000

This table illustrates the advance in the production of steel in Great Britain and in Germany from 1873 to 1913, i. e., forty years, and shows how far we were left behind in an industry in which we formerly held the first place. In the same way, our new competitors in shipbuilding will most certainly leave us behind unless we exert ourselves far more than we are doing; our shipbuilding industry will suffer and unemployment will follow.

* From a paper read before the Institution of Naval Architects, London, March 25, 1920.

To throw some light upon the cause for this rapid advance in Germany as compared with this country, I beg reference to the report of the Iron and Steel Institute, which states that in 1913 the weight of steel made per shift was approximately in the ratio of: English, 1; American, 1.5; German, 2—that is to say, the output per head in Germany was twice that of England.

I should like to say a word about the £40,000,000 put down as the cost to this country of emigration. People often speak of emigration as "a blessing, finding employment for the surplus population." To feed, clothe and educate from infancy those who ultimately emigrate to foreign countries is a clear expense to us. Assuming, in round figures, that 100,000 leave us annually to go to foreign countries (excluding the colonies), and assuming that an emigrant costs £400 to bring up, we are actually incurring an annual expenditure of £40,000,000 per annum for the benefit of other countries, and in some cases raising up future competitors. For example, in the United States we find that at least one-half of the shipyards are controlled by men from the Clyde and the Tyne.

In the United States and Germany, before the war, industries were developed with such rapidity that employment was found for even a greater number of people than the natural increase of the population, and immigration took place on a considerable scale into the United States and into Germany, while in this country our industries and trade did not keep pace with the increase of the population, and emigration was the result. Emigration from a country is an indication that industries are not being developed there at the same rate as the increase of population, while immigration indicates the reverse.

The only way to reduce the £40,000,000 sterling per annum drain on this country due to emigration is to do our utmost to increase our trade, so that people may find here profitable employment, which is dependent, as in the United States and Germany, upon developing our industries. Not only must we seek to produce cheaply, so as to secure trade, but we must not neglect the encouragement of science and research, because our prestige as a shipbuilding country depends not only upon building ships cheaply, but also upon our keeping well to the front in improvements. Following the example of the United States and Germany, an attempt is now being made by the government to encourage the application of scientific research to industries, and there can be no doubt that it would benefit the shipbuilding industry if more scientific men were introduced into private establishments. Evidence of this deficiency is proved by the tardy appreciation by many firms of the advantages to be secured by investigations carried out at the experimental tank at Teddington.

I venture to think that nothing will be seriously accomplished to remedy this deficiency until science is more generally taught in our schools, and to ensure this a greater number of the head masters must be drawn from men trained in science rather than from those trained in classics. To show the remarkable position as to the scientific attainments of the head masters of the seventy-three public schools in England, the degrees they have taken in various subjects, according to the British Association report on science teaching in 1917, were as follows:

Literary and classical	61
Mathematical	9
Science	3
	73

There is no doubt that to develop our industries, including shipbuilding, the head masters, while upholding the old traditions, which have been so successful in the past and have made the British Empire what it is, must advance with the times; and in an age when science is a necessity for the development of our trade, more attention must be given to scientific training in all schools, so that everyone, including our political leaders, may at least be conversant with the importance of science, in which they have been seriously deficient in the past.

I have tried to show how much financial and economic considerations have to do with our shipbuilding future. Put briefly, our shipbuilding industry depends:

1. Upon our shipbuilders being able to produce ships cheaper than our competitors, and shipowners being able to order ships from us instead of from abroad.

2. Upon our keeping well to the front in naval architecture, which is greatly dependent upon scientific research.

3. Upon our having in view that among our present competitors are the United States and Japan (and, later on, Germany), where the most up-to-date equipment is to be found in their shipyards and engine works. We must therefore adopt the most modern machines, and where old ones exist, which are costly to work, take Lord Fisher's advice and "scrap the lot."

Further, I think many firms might take more interest in the welfare of those in their employ, and by extending more human sympathy towards them in their daily business life inspire mutual confidence. This, I believe, is mainly to be obtained by personal intercourse between employers and employed, and it rests with the former to secure this end.

I would once more call attention to the heavy responsibility that rests upon those who make restrictions on labor which restrain our artisans from doing their very best, by insisting on arbitrary lines of demarcation or by reducing output or by preventing those who can and are anxious to work—both men and women—from so doing and thus render it impossible in the future for our shipbuilders to meet foreign competition.

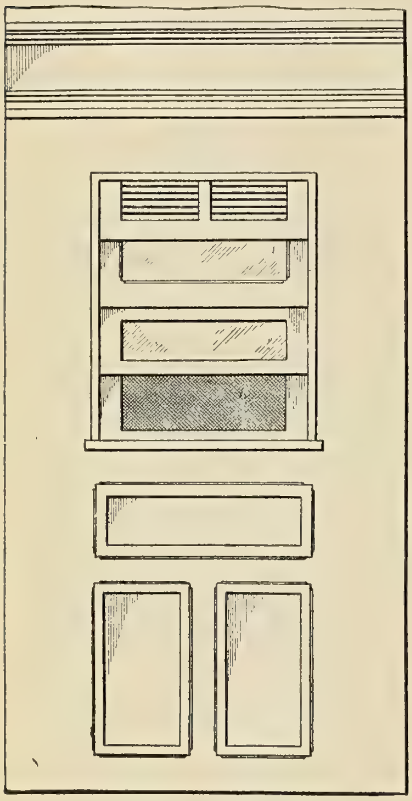
In face of these facts for anyone to imagine that by limiting output we are adding to our prosperity is inconceivable. This view, I feel sure, is not shared by the better-informed British workingman, for the vast majority are men of intelligence, and when they come to a full realization that slackness will not only imperil the nation but will injure their fellow-workers, they will, I feel certain, respond to the demands made upon them.

Improved Method of Installing Ship Windows

A NUMBER of ships built in the Harlan plant, Wilmington, Del., of the Bethlehem Shipbuilding Corporation, Ltd., have had a special type window installed which was invented by John S. White, superintendent joiner at this plant. This window is intended to provide a number of alternative sashes or closures and means for adjusting these without employing the customary canvas pocket in the sill. With the variety of sashes available, which include a blind or shutter, a storm sash, an insect screen and an ordinary sash, it is possible for the occupant of a cabin to control the light, ventilation, protection against insects and privacy as desired. A watertight sill is provided, and also a compartment above the window opening for stowing certain of the sashes when not in use.

In overcoming the undesirable features ordinarily encountered in ship window installations, the first problem was to get sufficient height above the window opening for sash stowage. To accomplish this, the house plate was made in two parts, which permitted the members to

stow immediately up against the under side of the overhead deck carlins, and then a small fixed storm sash, glazed with opaque glass, was installed in the upper exterior portion of the opening. This arrangement made the inner aperture higher than the outer, which in turn reduced the height and weight of the sash, blind and the larger members of the storm sash to such an extent that they could be stored overhead without the aid of spring tape balances or counterweights.



Improved Type of Ship's Window Fitted with Alternative Sashes

A desirable feature of the arrangement has been the introduction of the storm shutter or sash in such a manner that it can be operated by the occupant of the room as readily as the sash, blind or screen. The storm sash, by having two rectangular lights of heavy plate glass, one above and one below, permits vision in either a standing or a sitting position, and when stowed overhead, the lower glass registers with the glass of the small fixed storm sash. The light is thus permitted to enter the cabin at all times without sacrificing the privacy of the occupant.

To prevent the sash, the blind and the storm sash from sticking in periods of extreme moisture, the customary wood parting bead is replaced by a channel section of composition, in combination with small strips of sheet brass secured to both the inner and outer edges of the stiles. The face side of the channel section is punched with a series of diagonal slots at short intervals, and these, in combination with the spring-operated pin of the sash lock, throw the whole weight of the members against the edge of the metal parting bead. This produces an excellent anti-rattler and affords a means for locking the sashes in any desired position. Finally the insect shutter is so arranged (as the outside sash and operated from the inside by means of a spring plunger bolt) that when the remaining sashes are stowed overhead it is possible to use the windows as a means of escape in case of accident or fire.

The installation recommends itself to consideration, for it apparently has overcome many of the difficulties of the ordinary ship window.

Launching a 45-Ton Motor Tug from the Deck of a Transport

BY LIEUTENANT-COMMANDER H. A. ARNOLD, U. S. N. R. F.

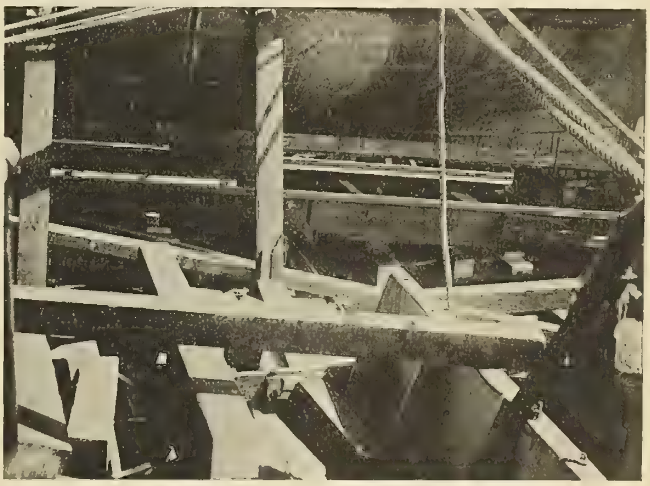
THE accompanying photographs, taken at the Cavite, P. I., Naval Station show the preparations for launching a forty-five-ton motor tug, which was brought from the Mare Island Navy Yard on the deck of the naval transport *Pensacola*. By means of a floating crane at the Mare Island Navy Yard, this tug was placed on the after-well deck of the transport, on a cradle built up of twelve by twelve timbers and braced with the same. The voyage from Mare Island to Cavite was made without any trouble.

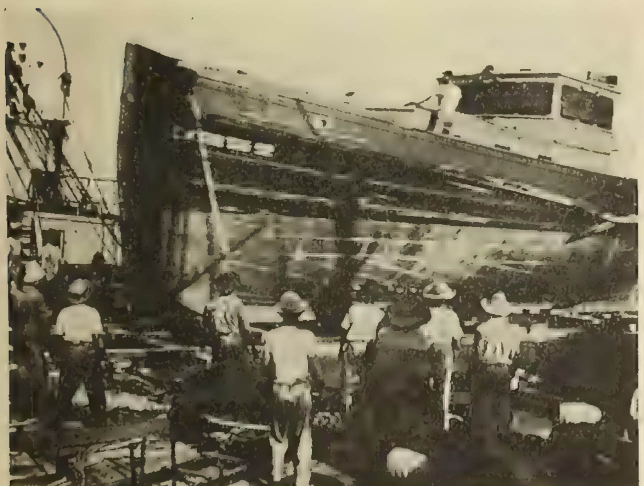
Motor Tug Ready for Launching from Deck of Transport. Launching Ways Laid Across Coal Barge Moored Alongside the Vessel

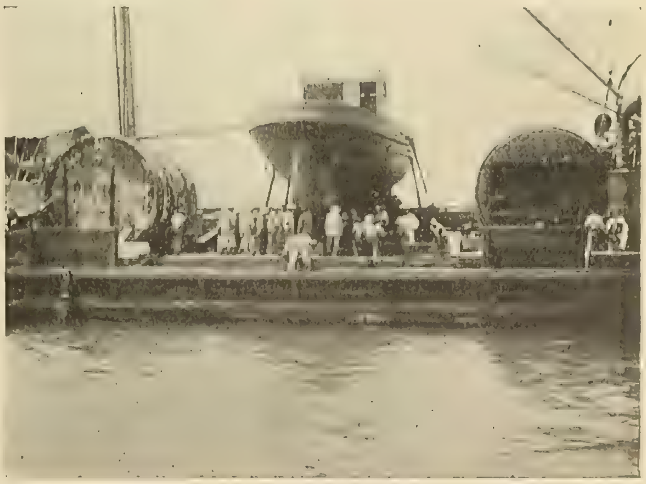
Views Showing Damage Sustained by Motor Tug in First Attempt at Launching

Upon arrival in Cavite the only shear leg which could lift fifty tons was the shear leg derrick, which was borrowed from the Army and taken alongside the *Pensacola.* The motor tug was slung with rope slings and made ready for lifting. The Army shear leg picked the tug up about four feet clear from the cradle, and without any notice or signs of weakening carried away, the tug landing part on the cradle and part on the ship's rail. The block from the shear leg went through the deck house of the tug, and the guard rail and keel were both slightly damaged.

The big job now at hand was to turn the tug around and build launching ways to float the tug. This job was done by taking a coal barge alongside the *Pensacola* and building ways from the ship to the outboard side of the barge. This work was done in five working days, and on October 1, 1919, the motor tug was launched without any trouble and is now in commission at the Cavite Naval Station.







Snapshots of Tug Showing Successful Method of Launching by Means of Ways Laid from Deck of Transport Across Coal Barge Alongside

Lubricating System for Geared Turbines*

Standard Oiling System Developed by the Emergency Fleet Corporation for Adoption on Vessels Equipped with Geared Turbines

BY J. EMILE SCHMELTZER AND B. G. FERNALD

As operating troubles with geared propelling turbines were already being reported to an extent considered abnormal, and as many of these troubles were being attributed to faulty operation or failure of the lubricating oil system (in most instances the oiling system was not furnished by the builder of the turbine, but by the shipbuilder), it was decided by the officials of the Emergency Fleet Corporation in the summer of 1918 to study all the oiling systems in use on American ships, and either adopt or develop a standard oiling system for use on all geared turbine vessels then under construction or to be built by the United States Shipping Board Emergency Fleet Corporation.

A very small percentage of American marine engineers had had any previous operating experience with direct-connected marine turbines, and a negligible number had ever operated double reduction geared turbines, the type with which most of the vessels under construction were equipped. This fact, together with the magnitude of the projected shipbuilding program, made it necessary to train many new engineers for marine service, and at the same time indicated the necessity of standardizing, as far as possible, the propelling equipment that they would operate. The standard oiling system was therefore primarily expected to accomplish improvement in operation rather than a reduction in construction costs.

It appeared that a standardized system would materially simplify the instruction of the new engineers. Lack of standardization, moreover, would have caused accidents and confusion, even with experienced engineers, as it was frequently necessary for engineering crews to go to sea on new vessels without first giving them time to familiarize themselves with the different piping systems on the vessels.

It was also believed necessary to incorporate into the system features designed to take care of the unusual war conditions.

Direct-Pressure System Universally Used

A preliminary study of the systems being used by the various shipbuilders disclosed the fact that, with one exception, they were of the direct-pressure type, which, from necessity of keeping all vital parts below the protective deck, had been standardized by the Navy Department. The one exception was a low-pressure gravity system not adapted to turbines requiring high pressure. The fundamental problem was to supply the bearings and gear tooth contact faces with an adequate and uninterrupted supply of clean, cool oil.

In July, 1918, a preliminary plan and description of an oiling system, modeled as above, was prepared and sent broadcast to shipbuilders, turbine builders, lubrication experts, etc., for criticism and suggestions. Much constructive criticism was received and much that was essentially a defense or justification of systems to which the critic was already committed by precedent, or in which he had some proprietary interest.

As a consequence of the criticisms, a revision of the system substantially according with the majority of the recommendations was made, and submitted again to a number of eminent marine engineers, and the final revised system adopted as a standard for vessels of the Emergency Fleet Corporation on September 16, 1918.

First Installation of the System

Late in the summer of 1918, it was decided to install the system on the S. S. *Westland,* then in Hoboken undergoing repairs. Due to the short space of time allowed, it was impossible to make the installation as complete as desired, but the necessary information as to the pumps, coolers and other equipment required was furnished to the Division of Operations, and they were installed under the direction of the representative of that division in New York. While the system as specified contains many refinements not included in the system installed on the *Westland,* the results obtained from the installation on this vessel were sufficient to assure those responsible for its design of the successful operation of the proposed system. The first vessels equipped with the entire system were delivered about the middle of January, 1919, subsequent to the signing of the armistice.

As the shipbuilding program, notwithstanding many cancellations, was far from complete, it was deemed advisable to make a further revision of the system to eliminate many features specified on account of war conditions, and also to eliminate automatic features rendered unnecessary by the increasing efficiency of the operating personnel, but retaining the essential features. This revision was issued on July 15, 1919.

Coolers

Nearly all of the oil coolers previously used were inadequate to transfer the required number of British thermal units, which amounted in a number of instances to 10 percent of the propelling turbine horsepower. This was partly due to the fact that the reduction-gear manufacturers had overrated the efficiency of their reduction gears.

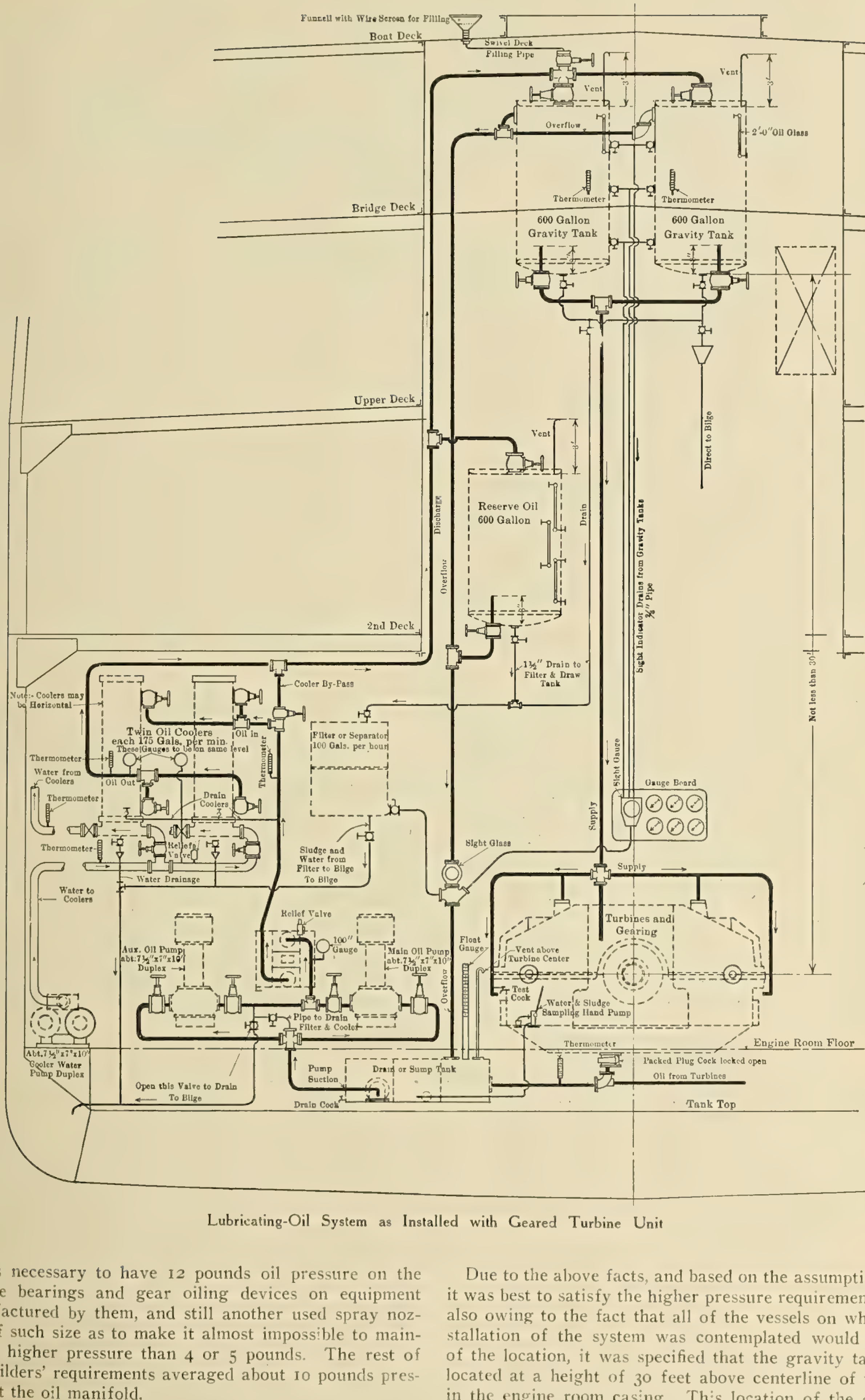
As a precautionary measure, it was considered essential that an auxiliary cooler be provided so that the oil could be cooled by one cooler in the event of the other being rendered inoperative by leaky tubes or other causes. The auxiliary cooler was also used in parallel with the main cooler when operating in tropical waters, where a cooling water temperature of 84 degrees or higher obtained. The technical order specified a 20-degree drop in oil temperature, while it was realized that the cooler would not be called upon to equal this temperature drop under normal running conditions, still this size of cooler provided for a considerable drop in the efficiency of the cooler, due to the fact that the tubes would in time become covered with a deposit which would materially decrease the efficiency of the cooler as compared with a clean one.

Results obtained in operation have demonstrated that the size of cooler specified satisfies average operating conditions.

Gravity Tanks—Size and Location

During the time the designs of the new system were in the course of preparation, one manufacturer claimed that

*From a paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1919.



Lubricating-Oil System as Installed with Geared Turbine Unit

it was necessary to have 12 pounds oil pressure on the turbine bearings and gear oiling devices on equipment manufactured by them, and still another used spray nozzles of such size as to make it almost impossible to maintain a higher pressure than 4 or 5 pounds. The rest of the builders' requirements averaged about 10 pounds pressure at the oil manifold.

Due to the above facts, and based on the assumption that it was best to satisfy the higher pressure requirements, and also owing to the fact that all of the vessels on which installation of the system was contemplated would permit of the location, it was specified that the gravity tanks be located at a height of 30 feet above centerline of turbine in the engine room casing. This location of the gravity

tank has proved very satisfactory in service, and no trouble has been experienced in securing the required pressure.

The size of the gravity tank, which is of 600 gallons capacity, was based on having three or four minutes reserve supply of oil available for the gears in the event of the oil supply to the gravity tanks being interrupted. This, it was thought, would provide sufficient time for action on the part of the operating personnel.

Kingsbury Thrust Bearing

Inasmuch as, on most of the various types of turbines purchased by the United States Shipping Board, the Kingsbury or similar type of thrust bearing is used, it is essential that there be a constant supply of cool, clean oil. Failure or interruption of the supply has caused the thrust bearing to burn out on several occasions, with consequent serious damage to the turbine.

This same type of thrust bearing was employed in the majority of cases for the main propelling shaft thrust, and therefore the same necessity for cool, clean oil obtained in this case.

Strainers

As a precautionary measure against sabotage, a twin suction strainer having a coarse mesh strainer basket was installed, but eventually omitted in the revised specifications at the end of the war.

A strainer having approximately 1/64-inch mesh was placed in the discharge line, and this is considered sufficient to remove all sediment incidental to ordinary operation after the system has been thoroughly cleaned before the trial trip as specified.

Filters and Separators

While all of the filters and separators specified are satisfactory for the purpose, it is considered that the results obtained from the centrifugal type of separator show greater efficiency, inasmuch as the oil, water and sediment are separated—the oil flowing from one nozzle, the water from another, the overflow mixture from another, and the sediment remaining in the bowl, from which it may be removed at will. Tests made at Annapolis prove that the rolling or pitching of a vessel will have no ill effects on its successful operation.

Filtering elements placed in gravity tanks or in the discharge line from pumps to gravity tanks at its connection to gravity tank, unless at sufficient height above, cannot function properly, due to the lack of sufficient head, which results in the oil following the path of least resistance, *i. e.*, through the overflow and not through the straining elements as intended.

Alarm Systems

An electric alarm system actuated by a float switch connected to the gravity tanks was provided (and since omitted), which would notify the chief engineer in his room and the engineer officer on watch, by means of an electric gong, that the oil level had dropped below normal operating level. This system, which was so designed as to not only give the necessary notification in case of oil level becoming low, but also to automatically increase the speed of the pumps, was later omitted, due to a desire to reduce the cost of the installation rather than because of any belief in a lack of necessity for it.

Drain Tank

The capacity of the oil-drain tank was required to be from 800 to 1,000 gallons for a 3,000 horsepower double-reduction gear turbine unit.

It was found that most of the drain tanks supplied at the time this system was originated were entirely too small, and resulted in the pumps becoming vapor bound. In most cases of this kind, and also where the suction lift of the pump was high, the oil became very dark in color. Oil experts who were consulted advised that the mixture of air with hot oil frequently resulted in the presence of sulphurous acid (H_2SO_3) in the oil. For this reason, the drain tanks were made sufficiently large and the pumps placed as low as possible to insure a short suction lift.

Pumps

While vertical pumps are more desirable for the purpose of securing low suction lift, it was not possible to procure them in the quantities required. Horizontal pumps were therefore used more extensively. The vertical pump is preferred to the horizontal, not only for the above good reason but also because of its taking less floor space and lending itself to better arrangement generally.

Oils

Originally an oil having a viscosity of 300 seconds (Saybolt) at 100 degrees F., was specified, but later this was changed to 500 seconds viscosity. This latter viscosity was found to suit conditions better because the high-speed bearings demand oil having a low viscosity and the gears and slow-speed bearings a high viscosity oil. Inasmuch as two separate systems could not be considered on account of their cost, and due to the fact that oils ranging from 300 to 700 viscosity at 100 degrees have practically the same viscosity at temperatures above 140 degrees, and also based on operating results, it was considered that the higher viscosity was more desirable.

Conclusions

The results obtained from the system in service have been very gratifying and show that the sizes of equipment specified were in keeping with the requirements, and it is believed that a system of lesser magnitude than that specified would endanger the successful operation of a double reduction gear turbine unit of 3,000 horsepower.

There is no doubt that an adequate lubricating oil system is essential to the successful operation of the geared turbine; and while its maintenance cost is small, the consumption of oil through leaks and other sources amounting to about half a barrel per month, the first cost of installing such a system is quite high. It is believed, however, that an increase in efficiency will be obtained in the reduction gears of the future, which will permit of a considerable reduction in the size, and consequently the cost of the lubricating oil system.

Lloyd's Quarterly Returns

THE returns compiled by Lloyd's Register of Shipping, which only take into account vessels of 100 tons and upwards, the construction of which has actually been commenced, show that there were 2,205 merchant vessels of 7,941,950 gross tons under construction in the world (excluding Germany, figures from which country are not yet available) at the close of the quarter ended March 31, 1920. Of this amount, 2,018 vessels of 7,801,450 gross tons were steamships. The leading place is accorded to the United Kingdom, where 865 merchant vessels of 3,394,425 gross tons were under construction; and the second place to the United States, where 535 vessels of 2,573,298 gross tons are recorded as under construction. In the United Kingdom there are three vessels of from 20,000 to 25,000 tons under construction.

Present-Day Marine Engineering Equipment

What the Modern Marine Power Plant Consists of and the Type of Man Who Is to Handle It—Some Things That the Young Engineer Must Learn

BY JOHN C. MC KENZIE*

THE world war produced conditions hardly dreamed of in the trend of the natural course of events. Regardless of its effects in all lines of industry, probably no branch was more completely revolutionized in a short space of time than the shipbuilding industry. That Denver, Col., would build cargo winches for our steamers, or that Chattanooga, Tenn., would furnish anchor windlasses was altogether unbelievable. The extremes of inland facilities were used to the utmost, as the cry was "Ships, ships and more ships."

The "fabricated ship" became a fact, and its results have set the world thinking, as Hog Island products have demonstrated the integrity and substantiability of this class of ship. How well they have succeeded needs no special mention, for the records these ships hold are not surpassed by any ships built by our older-established shipyards.

It was necessary, owing to this insistent demand for ships, that propelling machinery for ships be bought wherever it could, and that auxiliary machinery be obtained in the same manner. One of the most essential requirements of a steam-propelled vessel being a boiler, it was also necessary that these be built wherever possible. This was the principal reason for the watertube boiler being extensively used in our ships. Steel plate was in great demand, and Scotch boilers built of heavy plate could not be manufactured as quickly as watertube boilers, whose drums were built of thinner plate and could be turned out by almost any boiler manufacturer, no matter where his plant was situated.

The shipbuilding programme gave all concerned the opportunity of aiding the Government in its time of need. The turbine, watertube boiler, superheater and all the latest improved types of auxiliary machinery had their innings, and never before was such a volume of modern equipment installed in a cargo steamer. As far as the present equipment being placed on board of ship is concerned, it is doubtful whether ten years would have accomplished it, and in many cases our conservative steamship operator would never have done it.

What About the Engineer?

What about the marine engineer who is running this modern power plant? The fact is he is being educated in the same manner as our recruits during the war. We had to train our present-day marine engineer. It was necessary to send the majority of engineers to a turbine school. Again, many, to use a trite expression, were "butchers, bakers and candlestick makers," and they had to go to school to learn the first principles of marine engineering, and some have not learned it yet.

Is it any wonder that we see ships deserted at sea, later to be towed into port and found seaworthy? What a sad commentary on a nation which, in its day, prided itself on its leadership on the sea, when "sail was king"!

Wireless is a wonderful invention, but to the present-day marine engineer it is the refuge in all his troubles. Rather than pride in himself as a result of bringing his vessel into port, it is much easier to call for assistance.

We do not go backwards in the progress of the world, but, for illustration, let us take the case of the accident to the *City of Paris* on March 25, 1890, when she was towed to Queenstown, Ireland, five days later with her stern practically level with the water and her bow high out of the water, reaching port in a condition that was considered remarkable in that day. Did Chief Engineer Walls abandon his ship, although her propelling machinery was totally disabled? He did not. He brought her into port, showing the ability of the engineering staff. This vessel is the present *Philadelphia*, a veteran of two wars, and at that time the fastest ocean liner.

Or, again, take the case of the *Umbria*, when she broke her thrust shaft in 1892. Did Chief Engineer Tomlinson wallow around the Atlantic in a seaway and pray that some vessel would come along and give him a tow? He did not. Instead, repairs were made and she came into port under her own steam.

It is even on record that propellers have been fitted at sea, but a comparison cannot be made today, where so many propeller blades are being broken, and the writer has failed to see any record of a blade being fitted at sea. He does see numerous instances of the vessel being towed into port.

The specific instances cited above in respective steamers are well within the memory of the middle-aged engineer, but the writer does not believe the present-day engineer takes the interest in his machinery that his predecessors did. His predecessor loved his engine, believed in it, and had pride in it, for it meant a great deal to him. What would the late Superintending Engineer Doran say if he returned to life and saw marine engineering "as it is" instead of "as it was"? He would suffer a severe jolt, I fear, to see so many disabled craft, and all because engineering has become a secondary consideration to marine engineers.

About twenty-five years ago our stationary engineers, or power plant engineers as we term them now, were considered back numbers. A marine engineer in that day could always secure a good position ashore. What are the conditions today? Our high-grade power plant engineer is a peer in his line, and in a great many instances is far superior to his brother marine engineer. Why? Because he has kept abreast of the times and advanced with the times and knows the operation of modern equipment to the last notch. He knows the cost of every operation in his plant and efficiency is his watchword. This type of engineer would make our best marine engineer, if he were to take up that line; for modern equipment would not feaze him and he would make good, as he would be equal to the task.

Watertube Boilers

Take, for instance, the watertube boiler. This boiler is not an experiment but a development. The present Babcock and Wilcox marine watertube boiler is not the design of twenty years ago. No concern stands still, for they would quickly go out of business, and the various watertube boiler manufacturers took every advantage of

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the present situation, so that we have various types of watertube boilers afloat, to use an apt expression, good, bad and indifferent.

The watertube boiler is anathema to almost every marine engineer, simply because he believes what he wants to believe. He hears his elders say the watertube boiler is no good, and decides it is so, unless he does a bit of thinking for himself. Has he ever realized that the watertube boiler operates successfully in the navies of all nations? Does he know that our passenger liners are fitted with watertube boilers, and that with a little care and attention, well-designed boilers will respond by giving good results? Does he know that our fastest transports had watertube boilers, and "made good"? It simply resolves itself into this question—instead of the man mastering the equipment the equipment is mastering the man.

As far as present-day success is concerned, it is a strange fact, but very true, that our Pacific Coast engineer has had very little trouble with modern equipment. Why should that be so? The writer believes this to be the answer: Shortly before the war, the American flag was fast disappearing from the Pacific, and the marine engineer had to dig around for a job. He got any kind of experience he desired, and on that coast ran into watertube boilers. Knowing their ailments, he profited by experience, and invariably this type of engineer has kept free from watertube boiler trouble.

Condensers

The marine condenser has not undergone any change, to speak of, in decades. It is very much the same construction as of thirty years ago, except in naval practice. For the benefit of those not acquainted with the fact, a recent improvement in condenser construction has made its appearance on the market. The condenser is known as the "Lillie type," and its principal feature is to prevent sea water from leaky glands mixing with condensate.

Another cause of watertube boiler trouble has been due to engineers running the evaporator in an improper manner. With present-day turbine installation, 29 inches of vacuum is easily maintained—and herein lies one of the worst features of allowing watertube boilers to gain density. The turbine people demand efficiency, which is proper, and the marine engineer who is not familiar with watertube boilers gets inefficiency, both from the same source—high vacuum.

Can this be remedied so that both sides will achieve the same object? It is possible. Why not install sufficient evaporator capacity and have the vapor discharge into distillers of ample capacity, allowing the distillate to discharge into a tank, say, of 50 gallons capacity, then test the distillate before discharging same into the hot-well or reserve fresh-water tanks, as the case may be. For long voyages it would be desirable to install two evaporators, so that one could be kept in a clean condition as a reserve and interchange when necessary.

How about the testing of condensate for watertube boilers? The salinometer is too slow for accuracy. In many cases engineers have proceeded to sea without even knowing that there are proper outfits on the market for determining the exact number of grains of chlorine per gallon in the water tested. This procedure of testing the condensate and boiler water is the most essential to the satisfactory operation of watertube boilers at sea, and those engineers who have faithfully attended to this important detail have brought their vessels into port after covering 15,000- to 25,000-mile voyages without any boiler trouble.

Has the Scotch boiler been free from trouble? The repair yards could verify this question better than any other authority, as they are best qualified to speak. The Scotch boiler has ailments which will always be present, and according to our present operating conditions it would seem that the repairs will not lessen. The main difference between the two types is that the Scotch boiler will stand "salting up" to a greater degree than the watertube boiler.

Grease is an enemy to both types of boilers, yet, through carelessness or ignorance, that persistent trouble breeder will find its way into the boiler, causing furnace trouble in one type and tube trouble in the other type of boiler.

One of the best books published on marine boilers is that by C. E. Stromeyer entitled "Marine Boiler Management and Construction." It deals principally with the Scotch boiler, but the fund of information obtained will always benefit the young engineer.

The young engineer who is just starting out, trying to make his mark by advancing in his profession, cannot do better than write for catalogues concerning the equipment on his ship. He is bound to learn something, and it will keep him abreast of the times.

A few of our present engineers proceed to sea without proper tools for their equipment, which may be attributed to the fact of machinery appearing on shipboard which was hardly in evidence before the war.

What Is the Answer?

What is the answer to this question? The writer fully believes that a great many engineers are able and competent, but as regards the embryo engineer, with patience and training, possibly at least 25 percent (to put it mildly) will make good with present-day equipment.

The day will come when trade will slacken. At that time it will be "the survival of the fittest," and out of this conglomeration of engineers will rise the master who knows his equipment and who will make it respond to his will, and at that time we will again have real engineers who have benefited at the expense of our "Uncle Sam," as no private steamship operator would have dared train engineers in the manner it was compulsory for the Government to do.

We became a "maritime power" over night as it were, and as always "there are just as good fish in the sea as ever came out of it," so likewise will there be developed a school which yet may bring to the front ideas and successfully operate our modern marine power plant that will be a replica of our modern power plant ashore—the latest in ideas, the lowest in cost, the highest in efficiency.

The writer has not lost faith in the marine engineer measuring up to his responsibilities, as the world is in a transitory stage, passing through a period the like of which is not within the memory of those living. This has affected all lines of work and is possibly due to the intense pitch to which all were keyed up. Now that reaction has set in, the pendulum has swung to the other extreme. Water finds its level, so in like manner we shall return to normal and will regain the spirit of pride and objective.

The experienced marine engineer is in demand as never before, but he has to contend with conditions which are trying, as our younger engineers give him sleepless nights at sea. We were not born engineers, and many had to learn through the hard school of experience a far different lesson than the present day affords.

Breakdowns occurred, as now, and extra watches were the rule, but it produced a school from which all have made good, and when that same school looks back they are amazed at the changes and strides made in marine engineering, both as to working conditions and quarters, and the type of engineer that has succeeded them.

The Labor Problem and its Influence Upon the Merchant Marine of the Future

BY WALDON FAWCETT

SINGLENESS of purpose has, to a certain extent, characterized the consideration at Washington this past year of the issue of a permanent American merchant marine. Members of the two houses of Congress, who are favorable to merchant marine expansion, and the practical men of the shipping and shipbuilding industries, who have been acting as their advisers, have been engrossed, to the exclusion of all else, with the problem of finding the best means to transfer to private ownership the fleet acquired by the United States Government and to make the nation's resources in vessel property serve as the nucleus of an enduring, creditable and profitable merchant marine. But for all the concentration on the main issue, it has been impossible wholly to ignore certain incidental problems that have been revealed by the sidelights that have appeared.

An influencing factor, regarding which not too much has been said in the public discussions, but of whose existence all parties to the new arrangements have been vividly conscious, is the labor problem—that is, the equation of labor in ship operation rather than of labor in the shipyards, although the latter is involved also to some extent. All our readers will recall with what positiveness it was declared prior to the war that it was impracticable for American shipowners to operate in competition with certain other nationalities, notably the Japanese, and that there was laid at the door of labor conditions the responsibility for the situation which resulted in well nigh driving the American flag from the Pacific. With all the laws that fostered the old conditions yet on the United States statute books, it is inevitable that the labor problem in its various aspects should stand potent, if not menacing, in the background at the current deliberations on the subject of the merchant marine.

One Solution for Labor Problem

That the solution, or at least one solution, for the American labor problem in the maritime industries and for the high costs of operation is to be found in the employment of vessels of maximum size was the interesting theory advanced recently to the Senate committee on commerce by Harry H. Raymond, president of the American Steamship Owners' Association, president of the Clyde Steamship Company, president of the Mallory Steamship Company, and other corporations operating on their own account between 85 and 90 ships of an aggregate of approximately 260,000 tons. Appearing at Washington as the spokesman for the American Steamship Owners' Association, whose members own upward of two and one-half million gross tons of their own steam shipping, and in addition operate about four million tons of Government-owned vessels of the Shipping Board fleet, Mr. Raymond said:

"American sea wages have always been higher than the sea wages of other and competing countries. This fact throughout our existence as a maritime nation has made it necessary for American shipowners to conduct their business with the utmost enterprise and economy, to adopt all possible labor-saving improvements and, generally speaking, to operate larger ships than their rivals in ocean commerce. The wisdom of building and using relatively large ships was discovered 100 years ago by the merchants of New York, Boston, Philadelphia and Baltimore who operated the famous lines of packet sail ships across the Atlantic Ocean.

"By the year 1840 these packet ships had reached a size upward of 1,000 tons, or considerably larger units than most of the British merchant vessels of that day—larger, in fact, than nearly all of them except the frigate-built ships of the East India Company, which monopolized the traffic between the United Kingdom and Indian ports. Later on, when the celebrated American clipper ships, the speedier sisters of the packet ships were constructed, these also were of a size above the average, many of them of 1,500 tons gross register. Still later, when American wooden ships of the medium clipper class, built in the seventies and eighties, were actively competing with British iron ships in the great grain trade around Cape Horn from California to Europe, it was the American vessels, generally speaking, that were the largest and heaviest carriers.

Relatively Large Ships Most Profitable

"These facts are worth recalling from our earlier maritime experience to emphasize the truth which all maritime men of today understand, that it is the relatively large ships which can be made most effective and most profitable by American shipowners. A steamship of 10,000 tons requires no more deck officers or engineers than a steamship of 5,000 tons, and only a few more in number of the crew. That is to say, in the larger ships, carrying a larger cargo, each officer and man renders proportionately a greater carrying service than in the smaller ships, an economic fact of the utmost significance to the nation that pays the higher per capita wages. Moreover, American trade is characteristically a trade of relatively large cargoes, and many—in fact, most—of these cargoes are carried long distances."

At one point in the discussion that followed, Mr. Raymond expressed the opinion that the difference in wage cost between American-owned and foreign-owned tonnage is probably "a decreasing factor." Making specific comparison between a British ship of 10,000 deadweight tons and an American ship of the same capacity, he figured that the difference in the cost of wages of officers and crew would probably not be in excess of $12,000 (£2,460) to $15,000 (£3,080) per annum, or 20 to 30 percent, "with a tendency to decrease if British sea wages should rise still further toward an equality with our wages." To equalize this wage cost, the solution proposed by resolution of the American Steamship Owners' Association is that 10 percent of the net earnings of American ships be granted on account of depreciation and the amount deducted as operating expenses in the tax returns.

P. A. S. Franklin, president of the International Mercantile Marine, addressing the same group of senators was less optimistic with respect to the prospect that there will be a gradual narrowing of the gap between the cost of American ship operation and foreign tonnage operation. "Your steamship companies," he said, "are at an

additional expense of operation as compared to foreign shipowners and always will be from everything we can see, and unless they get some assistance from the Government they have a very slim chance of making a success of foreign trade in competition with the foreign flag steamers."

It has been represented to members of the national legislature at Washington and is a doctrine that has been accepted by many of them that the effect of the La Follette Act, which has been a thorn in the side of many an American shipowner, or prospective shipowner, will be gradually to compel foreign shipowners and operators to come up to the American standard of wages. Frank C. Munson, of the Munson Steamship Company, was closely quizzed on this point incident to a comparison he laid before the Senate committee as to the relative costs of operation of American and British ships. For the British steamer *Munardan* he gave a total payroll of $3,570 (£733) per month as compared with a monthly payroll on the American steamer *Walter D. Munson* amounting to $4,262.50 (£876).

Influence of the Seamen's Act

Answering a query as to the supposed leveling influence of the La Follette Act, Mr. Munson said that this might be true with respect to vessels with a terminus in the United States. He went on to say, however, that while a foreign ship coming into American ports regularly would gradually increase, because of the hiring of seamen in American ports at American wages, the wage outlay (this increase) would apply only to the ordinary personnel of the ship made up of seamen, firemen, coal passers, etc., and would apply only to a very limited extent, if at all, to officers who "stick by their ship." Mr. Munson figures that the wage expense is about equally divided in the aggregate between officers' pay and the wage of the crew. Not only, as he senses the situation, are the British officers to be counted upon to continue in their positions at lower pay than American officers of equivalent rank or responsibility, but he feels that the surplus of seafaring men in Great Britain, due to the fact that 9,000,000 tons of British shipping was sunk during the war, operates to induce British sailors to live up to their contracts more rigidly than do American sailors, despite the fact that American shipowners have voluntarily granted a post-war increase of $10 (2/1/8) a month to seamen and $15 (3/6/2) a month to firemen, which increases have not been matched by British ship operators. The disposition of the average member of a British crew to live up to his contract serves to perpetuate, of course, that disparity which it was prophesied that the LaFollette Act would gradually reduce, if not entirely eliminate. By signing a man for a year, the British shipowner gets firemen at $68 (14/3/4) per month as compared with $90 (18/18/0) on an American vessel, and able seamen at $63 (13/2/6) as against $85 (17/14/2).

Senator Chamberlain asked Mr. Munson whether the effect of the American seamen's law, while immediately discernible only in the influence for the elevation of the wages of foreign seamen and firemen, would not ultimately apply as well to the pay of foreign officers steaming to American ports who would behold the men under them receiving pay disproportionate to their own salaries. The answer was: "When we get to the time that the English merchant marine has absorbed the total number of excess crew and officers now available in England, then we will see a raise in wages probably of all of those men. Before that time it is going to be very difficult to raise the wages because there is an over-supply of that particular kind of labor. It will be at least four or five years before that can come about." Mr. Munson made it clear, however, that in so far as the United States is concerned, the raising of the wages of members of crews has had precisely the effect contemplated by Senator Chamberlain's logic—namely, a corresponding elevation of the pay of officers—and he pointed out that when the last readjustment was made the pay of all officers was advanced simultaneously with the wages of members of the crew.

A suggestion advanced by the head of the Munson Steamship Company that has received considerable attention at Washington was that embodied in his expression: "My feeling is that the laws should be changed in this country to permit of our absorbing as citizens British masters and British officers, of which there is a tremendous dearth in this country. We have been building ships so fast that we cannot officer them. We have been promoting men who are not capable of being officers—promoting them to be masters and chief officers—and we need those men in England who are not in demand. If we can bring them into American vessels we would fill the greatest need that we have in America today. We want American citizens running American vessels, but we want a chief engineer who knows his cargo and can fit her in shape. We do not want a chief engineer promoted from oiler who really does not know enough about his engines to keep them going."

Objection has been offered in Congress to any plan to encourage the transfer of British officers to American positions and supposedly to American citizenship on the theory that the interest and pride and ambition of the native Briton will always remain in British shipping. It has, indeed, been asserted that in some instances Englishmen have taken out "first papers" in the United States and have become officers of American ships without any intention of perfecting their citizenship. Mr. Munson has stated, however, that his observation and experience has been to the contrary. Relating the record of his own company, he stated: "We have had a very long experience with absorbing men who have come over here as British citizens to become American citizens. We changed vessels from the British flag to the American flag under the Panama Canal Act and we took over those men who were British officers, and nine-tenths of them became American officers."

The Labor Question in the Shipyards

His explanation of the disposition of an erstwhile British subject to stick as an American citizen, once he had become familiar with American shipping conditions, took into account the higher pay for both officers and men on American vessels, the superior accommodations and better equipment on the great majority of American vessels. Incidentally, this veteran shipping executive was asked as to the obvious difficulty of persuading American young men to take up the seafaring vocation as a life work. Mr. Munson's deduction was: "The American is willing to stick with the work if he gets to be an officer, but if he goes to sea as a seaman or if he goes to sea as a fireman, he does not stay. As a rule, he wants something better. That is particularly true of the coal-burning steamer; they do not like that kind of work because it is really heart-breaking work."

That the labor question is only slightly less important in the case of American shipbuilding than in the sphere of American ship operation was intimated by Homer L. Ferguson, president of the Newport News Shipbuilding and Dry Dock Company, in the course of a recent discussion at Washington. After remarking that the American shipbuilder has a certain advantage over his British rival "through not having to use a first-class mechanic

for every job that looks like a mechanic should be doing it," he turned to the other side of the picture and, contrasting conditions on the opposite sides of the Atlantic, said: "We have a good many mechanics, but we have not really the same proportion of skilled mechanics that they have. In England, generally, a man may not join a union until he has served his apprenticeship. Now, that is a right hard restriction on some boys, but it does tend to turn out good mechanics. If there is any one business where mechanics are still used, it is shipbuilding, because it is not repetitive work."

The Newport News shipbuilder went on to explain, though, that just in proportion as shipbuilding approaches quantity production does American specialization give the advantage to the firm on this side of the Atlantic. By way of illustration, he related: "They will have a man take a plate, punch it, furnace it, roll it, plane it, transport it and put it on a ship and bolt it. That is an operation that we perform with at least seven different trades. We will use at our place four or five platers to plate all of the ships that we can build on twelve ways. In a yard of that size in England, on the average they might have 75. We only use our expert men to do the jobs which require expertness, so we make up on that, frequently, a difference in the cost. The result is that the higher grade the ship, the more nearly we come to their cost. There is a notion that the cheaper ships can be more easily built in competition with them. That is largely fallacy. We will come nearer building torpedo-boat destroyers at the same price as the British yards than almost any other type of ship. With the higher grade ships you get a greater benefit out of duplication than you do in the lower grade ships."

That frequency of payment of the wages of ships' crews is a seemingly insignificant detail that tends to complicate labor problems is the idea advanced at the Capitol by Charles H. Potter, president of the United States Ship Operators' Association. Mr. Potter takes the position that sailors receive their money too frequently for their own good and that the short intervals of payment are a decided disadvantage to ship operators in that frequently ships must be held in port in order to secure other men to replace those who have disappeared after receiving their pay. The prohibition laws now in force in the Capitol by Charles H. Potter, president of the United result in a better morale on the part of the men in the coastwise trade, but he does not hold, as do some prominent members of Congress, that the result of the "dry" laws will ultimately be to attract a better class of men to American ships whether engaged in the coastwise or in the foreign trade. The United States Ship Operators' Association has, as the result of a questionnaire sent to all of its members, sent to Washington a recommendation that the present maritime laws be so modified as to attain increased usefulness for American vessels without any material sacrifice of American standards.

Repairing Defective Propellers

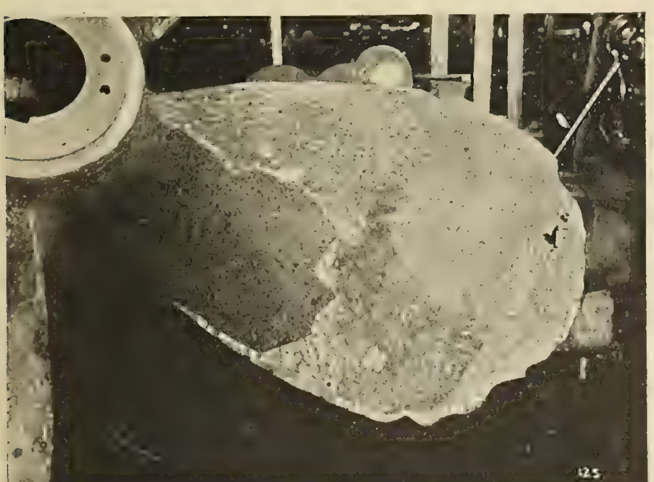
BY CHARLES T. PERRY

MUCH time and effort have been more or less wasted in the past by trying to repair broken or badly pitted propellers by welding cast iron tips to the blades with the oxy-acetylene torch or the electric arc.

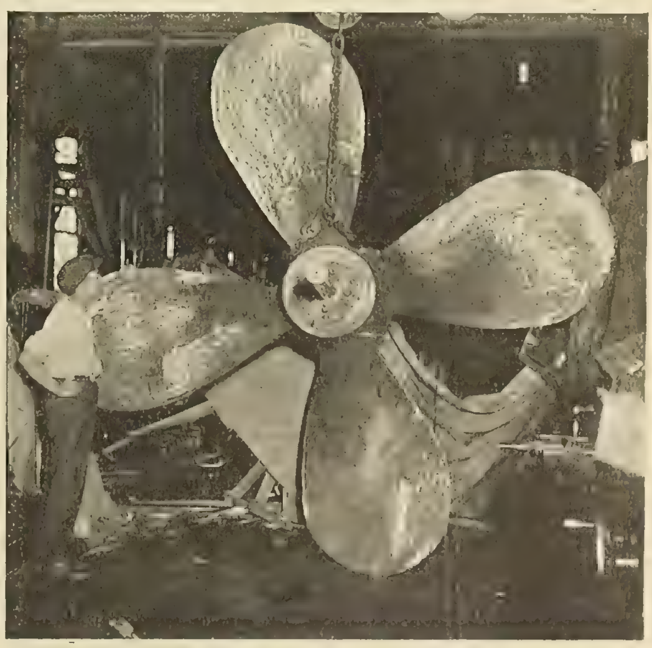
When the oxy-acetylene process has been used the excessive heating of the tip accompanied by an almost noticeable expansion and necessarily an equal contraction on cooling causes internal strains to be set up in the metal. When propellers repaired in this manner are subjected to stress they almost invariably break at the weld. Heating also tends to warp the blade badly, because of its wide area and relatively small thickness.

The electric process is found to be objectionable in certain respects, although the results obtained in repairing propellers by this means has been more satisfactory than when oxy-acetylene has been used. Fractures are frequently found near the weld after a repaired wheel has been put back in service. The only apparent reason for fracturing is the fact, that because of the slightly different composition of the material in the weld than the rest of the blades a galvanic action is set up which in time causes pitting along the line of the weld.

The engineering department of New York City has developed a method of repairing the broken cast steel propellers of the municipal ferries, which are subjected to unusually rough usage. The method consists in thoroughly cleaning all broken edges and pitted places, filling them in by the electric welding process and building up the tips to their regular size by this means. Special jigs



Propeller Blade Cleaned and Ready for Electric Arc Repair Process



On the Final Inspection This Repaired Propeller Proved to be Less Than Two Pounds Out of Balance

Scrapped Propellers That Have Been Salvaged and Repaired by Building Up Tips by Means of Electric Arc Welding

and templates are used, to maintain the proper blade thickness and contour. After welding, the wheels are dressed with portable grinders. Excessive heating of the tip is prevented throughout the welding operations and no line on the fracture is established.

With slight modifications and different electrodes the same process might be adapted to the repair of cast iron and alloy propellers. A metallic electrode should be used with a voltage not over 40 in any case, and the best of materials and workmanship are essential to insure a successful repair. The welded edges and tips of a propeller seem to stand concussion better than the original metal.

Attachment for Hydraulic Systems

A DEVICE to be used in connection with an hydraulic system, especially with a telemotor employed as the operating gear for a marine steering engine, has been invented by Frank J. Davis, of the Union Plant, San Francisco, Cal., of the Bethlehem Shipbuilding Corporation, Ltd.

Installation

The attachment is to be installed at the highest point of an hydraulic system and used to vent accumulated air and to admit liquid from an outside source of supply. The valve provided to control the escape of air is normally maintained in a closed position by the liquid in the system, but is arranged to open automatically by the pressure of an air pocket at the valve. This air vent valve is also arranged to admit liquid as the valve is vented, so that a control is provided for closing it after the venting action has ceased. The device may be used to replace the closing plug now employed in heads forming part of an hydraulic system. In Fig. 1 is shown a sectional view of the attachment.

Details of Devices

The installation includes a valve casing which fits onto a threaded nipple attached to the head. A lateral pipe connects this casing with a tank. This tank contains a supply of liquid used for floating the valve, which is mounted on a cork float. The valve seat is arranged at the base of the vertical port in the casing, the upper end of the port communicating with the chamber in the valve casing, to which a pipe leads from the tank. A guide stem having lateral wings fitting the vertical port is secured to the valve and permits the flow of air or liquid along the stem. When in a lowered position, the float is allowed to rest on raised projections on the top of the fitting within the casing, lateral passages being provided to maintain free communication between the interior of the valve casing and the bore of the fitting.

By reason of the bore, the interior of the valve casing which forms the float chamber is always in communication with the hydraulic system through the head, so that under normal fluid conditions the liquid in the system will maintain the float when the valve is closed. The formation of an air pocket, however, in the head, and hence in the float chamber of the valve casing, will permit the float to drop by its own weight, the valve thereby venting the casing and permitting accumulated air to escape through the port, chamber and pipe to the tank. At the same time the liquid will flow through the pipe to the float chamber, so that upon restoration of the normal liquid conditions in the system, and hence in the head, the float will rise and close the valve.

A shut-off valve is provided, arranged to seat within the casing at the upper end of the port. The stem of this valve extends upwards through the top of the casing. It is provided with a hand wheel for operating the valve.

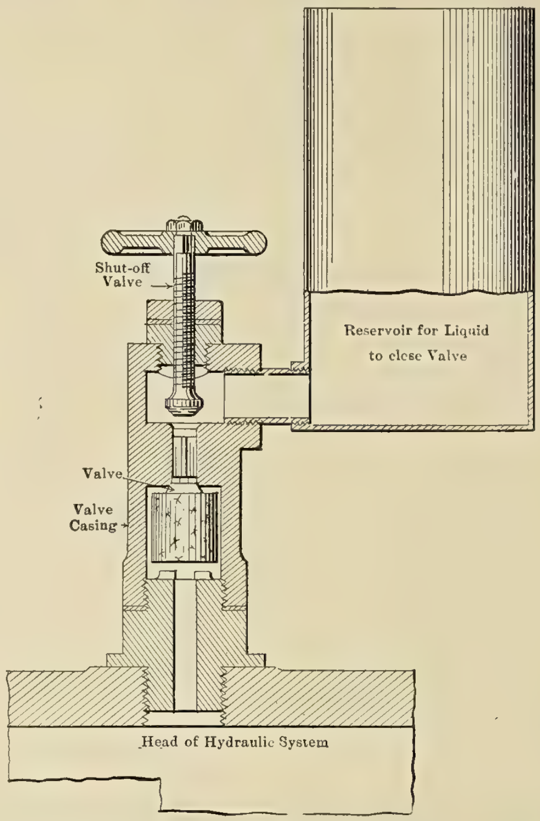


Fig. 1

The valve stem extends through and has a threaded connection with a nut and lock nut above the casing, suitable packing being provided between the nuts.

Institution of Naval Architects to Hold Summer Meeting in Liverpool

The council of the Institution of Naval Architects has accepted an invitation to hold a summer meeting in Liverpool on July 6, 7 and 8 which has been extended to the Institution by the Lord Mayor of Liverpool. Meetings for the reading of papers will be held, and arrangements will be made to visit some of the principal shipbuilding and other works in Liverpool and its vicinity.

Applications for membership or associate membership should reach the secretary not later than June 28, and for associates or students not later than July 3.

13,000-Ton Motorship *Afrika* Built by Burmeister and Wain for the East Asiatic Company. Two 2,250 Indicated Horsepowei Diesel Engines are Installed

Motorship Building in Europe

Trials of 13,000-Ton Motorship Afrika—Fast Motorship Launched for Glen Line—Activities in France

BY OUR SPECIAL LONDON CORRESPONDENT

TWO very important events in motorship building in Europe have occurred during the past month. In the first place, the largest internal-combustion-engined ship which has yet been completed ran her trials at Copenhagen and, secondly, an even bigger and faster vessel was launched at Glasgow. The first-named craft, which is the *Afrika,* built for the East Asiatic Company by Burmeister and Wain, carries 13,000 tons of cargo, has a speed of about 12 knots and a fuel consumption of only 15 tons of oil per day. The type has now been adopted as a standard by the East Asiatic Company and a number of similar vessels are under construction, as it is the belief of most shipping firms in Europe that the high speed and large class of cargo vessel will prove more economical in the future than the average 10-knot, 6,000-ton type which has hitherto been mostly employed.

There is no special novelty in the machinery of the *Afrika,* the propelling plant comprising a couple of six-cylinder Burmeister and Wain standard engines developing 2,250 indicated horsepower each, or about 1,750 brake horsepower. They have cylinders 740 millimeters stroke and 1,150 millimeters bore and run at 115 revolutions per minute for normal power. The auxiliary machinery perhaps is of more interest. Needless to say, it is all driven by electric motors, as Scandinavian motorship owners are now fully convinced that this system is infinitely preferable to the adoption of steam auxiliaries, owing to the saving in fuel which is effected. Three separate electric generating sets are installed, each driven by a two-cylinder, four-cycle Diesel engine, the generators having an output of 65 kilowatts at a voltage of 220. When in harbor and all the winches are in operation, two sets will be required, but at sea only one is necessary, so that there are usually two spare plants and always a minimum of one to act as a stand-by.

A 14,000-Ton Motorship

In addition to the completion of this new ship, the second occurrence of unusual interest during the past few weeks is the launch of a fast motorship, which, when completed, will be even larger than the *Afrika.* This vessel, named the *Glenogle,* has a deadweight carrying capacity of 14,000 tons and has been built for the Glen Line by Messrs. Harland and Wolff at Glasgow. Not only is she a good deal bigger than the *Afrika,* but she will be one of the fastest cargo vessels afloat, having a speed of between 14 and 14½ knots. In order to attain this relatively high speed, two Diesel engines of 3,200 indicated horsepower are to be installed. They are eight-cylinder sets, of the same designed power as those fitted in the motorship *Glenapp,* but many modifications have since been made, and they represent a type which Harland and Wolff is now standardizing for installation in a large number of motor vessels under construction.

It will be noticed that one of the features of European motorship building is for the speed of the newer vessels to be much higher than is generally considered advisable for the average cargo boat, and quite the majority of internal-combustion-engined vessels which are now being built at European yards have a speed of from 12 to 14

knots. The *Glenogle,* which is 502 feet in length, with a beam of 52 feet (dimensions exactly similar to those of a number of passenger and cargo boats being built by the New York Shipbuilding Corporation in which steam machinery is to be installed), is to be provided with electrical auxiliaries, and in addition to cargo carrying will have accommodation for a limited number of passengers. It is clear that we are gradually tending towards the production of motor passenger ships, and there are already rumors that Harland and Wolff contemplates building such craft at their Belfast yard, where extensions have recently been carried out for the engineering shop.

A week or two ago another motorship was added to the Glen Line fleet. She is the *Glentara,* which is one of the types of motor vessels carrying 10,500 tons fitted with a couple of oil engines developing about 3,000 horsepower. A similar vessel was launched at Belfast also by Harland and Wolff in April. She is for the Bibby Line, which thus enters the ranks of motorship owners for the first time.

Oil Engine Building in France

Hitherto little has been done in motorship construction in France, but there are signs of awakening activities, and Schneider and Company is building eight single-screw, 4,000-ton vessels, in each of which this company is to install one of its new type 1,500-brake-horsepower, two-cycle engines with six cylinders. These motors possess many features of unusual interest. In the first place, they are perhaps the only design built by any important engineering concern in which scavenging valves in the cylinder cover are still retained, the more usual method being, of course, the employment of ports at the bottom of the cylinder uncovered by the piston in the course of its stroke. The Schneider Company has, however, had considerable experience in valve scavenging and apparently prefers to continue its adoption at any rate on engines of this size. There are six cylinders, 540 millimeters bore and 800 millimeters stroke, the speed of revolution for 1,500 brake horsepower being 140 revolutions per minute. A three-stage air compressor is mounted on the end of the crankshaft in the usual way, while the scavenging pumps, of which there are two, are driven by means of beam levers off the crossheads of the two central cylinders. There are four scavenging valves in each cylinder cover in addition to the fuel inlet valve, and the exhaust is, of course, discharged through the exhaust ports at the bottom of the cylinder, which have the advantage of occupying the whole of the periphery; this is not possible in the ordinary port scavenging design. The engine, which is of the crosshead type, is built up with a box framing, which gives an open design with accessible main crankshaft bearings.

Those British shipbuilders who have not yet started constructing oil engines are showing great haste to take up its manufacture, as they are being pressed on all sides to produce motorships as quickly as possible. Alex. Stephen and Sons, one of the oldest-established Clyde shipbuilding firms, which has hitherto kept aloof from oil engine development, has now acquired a license for the Sulzer Diesel engine. Among engineers who have had experience with various types of Diesel motor it is considered that this Swiss-built engine is likely to become one of the most widely adopted in the future for ships, and the fact that two such famous concerns as Armstrong Whitworth and Stephens have both adopted it as their standard oil engine is a strong point in its favor.

The builders of the Sulzer engine claim a big advantage over the four-cycle type in the diminished weight and the smaller engine room. With two engines each of about 1,500 indicated horsepower, the weight of the total installation for the Sulzer plant is only about 320 tons, against over 500 tons for a corresponding four-cycle Diesel plant. On the other hand, the believers in the four-cycle type claim that, while this design has proved its reliability in service over many years, the two-cycle engine has yet to reach this position, while there is no doubt that the four-cycle type is more economical in fuel consumption than the engines operating on the two-stroke principle. The difference, however, is not very marked and probably not more than about 5 percent as a maximum.

Large Passenger Liner Under Construction at Wallsend Shipyard

On February 7, Messrs. Swan, Hunter and Wigham Richardson launched from the berth once occupied by the famous Cunard liner *Mauretania* at their Wallsend shipyard a 20,000-ton passenger vessel which is being built for the Navigazione Generale Italiana, of Genoa. This ship, called the *Giulio Cesare,* is to run in the owners' service between Genoa and Buenos Aires, and will be one of the most luxurious of the many passenger liners plying between Europe and Argentina. The overall length of the vessel is 633 feet, and the breadth 76 feet, with a molded depth of a little over 50 feet. The ship has a straight stem and a cruiser stern.

The propelling machinery and boilers have been built by the Wallsend Slipway and Engineering Company, Ltd. The main engines consist of four geared turbines driving four propellers. The high- and low-pressure turbine units work in series, which arrangement applies both to the ahead and astern direction of rotation. The steam is superheated up to 200 degrees F. on entering the turbine maneuvering valves. In case of a breakdown to any of the turbines, they are arranged so that the high-pressure and low-pressure units can be operated independently. There are six double and four single-ended multitubular boilers placed in four watertight compartments. The working pressure of the boilers is 222 pounds per square inch, under Howden's forced draft. The designed speed of the ship is 19½ knots on a 24 hours' continuous trial.

The *Giulio Cesare* has eight decks, which are chiefly occupied with accommodations for 1,800 passengers, of which 210 are first class, 310 second class, and the remainder emigrants.

The *Giulio Cesare* is fitted throughout with hydraulic lifting gear for passengers' baggage, stores, and a small amount of cargo. An extensive electric generating plant will be installed in the ship for lighting, and also to work the first-class passenger lift and other lifts dealing with stores, etc. For the provision rooms there will be a large installation of refrigerating machinery supplied by Messrs. J. & E. Hall, of Dartford.

The *Giulio Cesare* is being built to the requirements of the Registro Nazionalo Italiano, of Lloyd's and of the British Corporation. She will also fulfill the provisions of the Merchant Shipping Laws of Italy, Great Britain and the United States, especially as regards carrying passengers and emigrants. When designing the ship, a great deal of attention was paid to ensure her safety as far as possible by providing a sufficient number of watertight compartments. A very effective installation of watertight doors controlled from the bridge is being installed by Messrs. J. Stone & Company of Deptford, London. On the boat deck, Welin's patent davits are fitted. Electric boat winches are provided for lifting all the midship lifeboats, which include two motorboats. The ship also carries submarine signalling apparatus which will be invaluable for picking up position in fogs.

Testing the Hull Structure of Ships

Test Schedule for Cargo Vessels—Rules and Methods for Testing Peak and Ballast Tanks and Forward Collision Bulkhead

BY F. K. RUPRECHT

THE testing of the various parts of the finished hull structure of a steel vessel is a subject of great importance. As a rule, this matter is given very little attention until the time of test arrives and consequently a great deal of needless confusion and delay, as well as great expense and waste, is the result.

The usual practice in shipyards is to designate a testing foreman, who chooses a gang of men to assist him in preparing the structure to be tested and to assist in the test itself. This gang carries on the preliminary tests and does whatever work is necessary in order to have the tank, bulkhead or deck, as the case may be, pass muster. Only in a very few yards is testing work carefully planned and scheduled and otherwise given the attention it deserves. It is a most common occurrence to come across a job where no one in the yard is sure what kind of a test and how severe a one is required on a given piece of work. As a result, the testing is done blindly, or upon hazy and incorrect instructions to the foreman in charge. This has, to the author's personal knowledge, resulted in severe damage to tank tops and bulkheads by subjecting them to a pressure in excess of what was called for by the classification rules, as well as in excess of the design conditions.

A ship is designed and built to perform a certain work. To perform his work satisfactorily is the function of the ship. Now, parts of the structure will be called upon to perform certain kinds of work, and the object of testing is to insure the owners and underwriter that they are capable of rendering this service; hence the real culmination of the shipbuilder's efforts is (or should be) to pass the test. Looking at the matter from this view, the importance of the test is seen and the work should be planned accordingly.

Take, for example, a tank ship to carry fuel oil. It makes no difference how pretty the workmanship may be, the shell, bulkheads and decks must be tight under the test head prescribed by the classification society before the workmanship is passed as satisfactory. No matter what nice lines and proportions or finish this vessel may have, she is not an insurable risk for the underwriters, unless the tanks have been tested and passed by an accredited surveyor.

We have all heard the catch phrase, "The play's the thing," as applied to the moving pictures. In shipbuilding "the test's the thing."

Having come to the conclusion that testing is a highly important part of the work, it is surprising to see so little information on this subject available. All the necessary information is given in the rules of the various classification societies, but it is scattered around in all the numerous sections. An attempt is made in this paper to gather it together and present it in a concise form for quick and easy reference. A few notes are also given on procedure, which may be of value to shipbuilders.

Test Schedule for Cargo Vessels

Test No. 1—Fore Peak Tank

(*a*) *Object*

To test tightness and strength of peak bulkhead, shell in way of tank, deck forming crown of tank, manholes and pipe connections to tank top, bulkhead or shell.

(*b*) *Classification Societies' Rules*

1.—American Bureau of Shipping and British Corporation Registry.

To be tested with head of water equal to load draft, or .66 × depth of vessel, or with head to one foot above highest point to which water may rise in service condition, whichever is greater.

(Note.—Highest point to which water may rise would be top of vent pipe, overflow pipe or filling connection, whichever is greater.)

2.—British Lloyd's Register.

To be tested with a head of water eight feet above the top of the tank, or with a head to the height of the load waterline, whichever is greater.

3.—Bureau Veritas.

To be tested with a head of water eight feet above the top of the tank, or with a head to the height of the load waterline, whichever is greater.

(*c*) *Procedure of Testing*

Test before cementing or cement washing or painting with bitumastic, and, if possible, before launching and after all work within and adjacent to tank has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to launching date or other contingencies, the final approval of test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a retest obligatory.

Fit stand pipe onto tank top (vent or filling connection may be used) and carry pipe to prescribed height fitting large funnel or other container at top, the height of which is to be such as to show the level of water when at the testing head. No leaks or defects should develop at this pressure, and any found should, of course, be made good by legitimate means to the satisfaction of the surveyor. Often it is not possible to test completely before launching, and in this contingency it is necessary to have a preliminary test to insure the tightness of the shell in way of tank. In this case the tank is filled with water to the level of the crown of the tank and the shell made tight to the satisfaction of the surveyor.

Test No. 2.—After Peak Tank

(*a*) *Object*

To test tightness and strength of bulkhead, shell in way of tank, deck forming crown of tank, manholes and pipe connections to tank top, bulkhead, or shell.

(*b*) *Classification Societies' Rules*

1.—American Bureau of Shipping and British Corporation Registry.

To be tested with head of water equal to load draft, or .66 × depth of vessel, or with head to one foot above highest point to which water may rise in service condition, whichever is greater.

(Note.—Highest point to which water may rise would be top of vent pipe, overflow pipe or filling connection, whichever is greater.)

2.—British Lloyd's Register.

To be tested with a head of water eight feet above the top of the tank, or with a head to the height of the load waterline, whichever is greater.

3.—Bureau Veritas.

To be tested with a head of water eight feet above the top of the tank, or with a head to the height of the load waterline, whichever is greater.

(*c*) *Procedure of Testing*

Test before cementing or cement washing or painting with bitumastic, and, if possible, before launching and after all work within and adjacent to tank has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to launching date or other contingencies, the final approval of test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a retest obligatory.

Fit standpipe onto tank top (vent or filling connection may be used) and carry pipe to prescribed height fitting large funnel or other container at top, the height of which is to be such as to show level of water when at testing head. No leaks or defects should develop at this pressure, and any found should, of course, be made good by legitimate means to the satisfaction of the surveyor. Often it is not possible to test completely before launching, and in this contingency it is necessary to have a preliminary test to insure the tightness of the shell in way of the tank. In this case the tank is filled with water to the level of the crown of the tank and the shell is made tight to the satisfaction of the surveyor.

Test No. 3—Double-Bottom Ballast Tanks

(*a*) *Object*

To test tightness of shell plating in way of double-bottom, tank top plating and margin plate, strength and tightness of watertight floors and centerline division plating (centerline girder), manholes and pipe connections to tank top, watertight floors, centerline girder or to shell.

(*b*) *Classification Societies' Rules*

1.—American Bureau of Shipping and British Corporation Registry.

To be tested before launching and before cementing with head of water up to freeboard deck or to the top of overflow from air pipes, whichever is highest.

2.—British Lloyd's Register.

To be tested with head of water to the height of the load waterline.

3.—Bureau Veritas.

To be tested before launching with head of water corresponding at least with the height of the load waterline. In any case, the head of water must not be less than eight feet above the crown of the tank.

(*c*) *Procedure of Testing*

Test before launching and before painting with bitumastic or cementing or cement washing, and after all work within and adjacent to tank has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to launching date or other contingencies, the final approval of test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a retest obligatory. This would necessitate placing the vessel in dry dock. Each tank to be tested separately so all sides of divisional floors or girders such as watertight centerline girder may be observed.

Fit standpipe to tank top (vent or filling line may be used) with large funnel or other container at top and at such a height that the level of water at the required head will show in the container. No leaks or defects should develop at this head, and any found should be made good by legitimate means to the satisfaction of the surveyor.

Test No. 4—Deep Ballast Tanks

(*a*) *Object*

To test the strength and tightness of the boundary bulkheads, deck forming crown of the tank, shell in way of tank, inner bottom in way of tank in double-bottom vessels, all manholes, hatches, hatch covers and pipe connections to tank top, inner bottom, bulkheads or shell.

(*b*) *Classification Societies' Rules*

1.—American Bureau of Shipping and British Corporation Registry.

To be tested with head of water equal to load draft, or $.66 \times$ depth of vessel, or with head to one foot above highest point to which water may rise in service condition, whichever is greater.

(Note.—Highest point to which water may rise would be top of vent pipe, overflow pipe or filling connection, whichever is greater.)

2.—British Lloyd's Register.

To be tested with a head of water eight feet above the top of the tank, or with a head to the height of the load waterline, whichever is greater.

3.—Bureau Veritas.

To be tested with a head of water eight feet above the top of the tank, or with a head to the height of the load waterline, whichever is greater.

(*c*) *Procedure of Testing*

Test before launching and before painting with bitumastic or cementing or cement washing and after all work within and adjacent to tank has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to launching date or other contingencies, the final approval of test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a retest obligatory.

Fit standpipe to tank top (vent or filling line may be used) with large funnel or other container at the top and at such a height that the level of water at the required head will show in the container. No leaks or defects should develop at this head, and any found should be made good by legitimate means to the satisfaction of the surveyor.

Often it is not possible to test completely before launching, and in this contingency it is necessary to have a preliminary test to insure the tightness of the shell in the way of the tank. In this case the tank is filled with water to the level of crown of tank and shell made tight to satisfaction of the surveyor.

Test No. 5—Forward Collision Bulkhead

(*a*) *Object*

To test strength and tightness of the bulkhead and tightness of all connections thereto. While the shell must, of course, be tight, the test is primarily to test the bulkhead.

(*b*) *Classification Societies' Rules*

1.—American Bureau of Shipping and British Corporation Register.

No definite rule to cover this particular case. Appears that a hose test is all that would be required. Pressure in nozzle to be at least 30 pounds per square inch.

2.—British Lloyd's Register.

To be tested by filling the peaks with water to the height of the load waterline.

3.—Bureau Veritas.

To be tested by filling the fore peak with water. (Note.—No head is given, but it is assumed that it shall be to the freeboard deck, or at least to the load waterline.)

(*c*) *Procedure of Testing*

Test before cementing, cement washing or painting with bitumastic and before launching, if possible, although the latter is not a requirement, and after all work within and adjacent to bulkhead has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to launching date or other contingencies, the final approval of test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a retest obligatory.

Fill the fore peak compartment, i. e., that space between the stem and the collision bulkhead, with water to a height equal to *at least* the load waterline. If there is a calked watertight deck above this level it is well to fill to this level, since this would be more nearly the head the bulkhead must withstand in case of a damaging collision. No leaks should develop at this head, and the deflection of the bulkhead should be reasonably small. Any leaks which are found should be made good by legitimate means, and any excess deflection should be corrected by additional stiffening, all to the satisfaction of the surveyor.

(*To be continued.*)

Stoke-Hold Efficiency—IV

BY A. POHLMAN

IN preceding articles the flue gas analyzer and draft gage were described and their uses explained. There remains, however, another very important instrument for use in the work of improving stoke-hold efficiency, and that is the pyrometer, which is used for temperature readings.

Pyrometers of the expansion or of the electrical type are most commonly used. Of the two types the electrical instrument is the more desirable, inasmuch as several thermo couples may be placed at various points and connected to a meter at some convenient place by means of leads, so that by means of a switch readings can be taken from the different couples. The expansion instrument, on the other hand, must be carried from one point of reading to another.

In the case of a watertube boiler installation a pyrometer pays for itself many times over, as by its use broken down baffles, causing a short circuiting of the flue gases and a consequent loss of efficiency, are detected at once. Temperature readings in the different passes of the flue gases should be taken daily. If the readings fail to show a drop in temperature from one pass to the next, they usually indicate broken baffling. If the readings show a higher temperature in the back end, where the baffling is known to be secure, it shows that secondary combustion has taken place. This means that all the mixture is not being manufactured in its proper place—the firebox.

A very common cause for low CO_2 and high temperatures in the wrong place in watertube boiler installations, where the header type of boiler is used, is the lack of proper packing between headers.

The effect of soot on the heating surface of a boiler is also quite apparent when the pyrometer is used. Wherever the heating surfaces are accessible they should be cleaned of soot at least once a day, and for this purpose the mechanical soot blower should be used. Blowing with a hose and lance is a nasty and expensive job, and very often the apparatus is not available. At the best, where the hand method is used, the soot is blown from one corner to the other and the surfaces are not effectually cleaned.

Where superheaters are installed in the uptakes, as in Scotch boilers, special care should be taken to be certain that the superheating surface is well cleaned of soot. With the mechanical type of soot cleaner the heating surfaces may be blown free of soot and the whole operation can be carried out in a few minutes for each boiler. When it is realized that a layer of soot one-fifth of an inch thick forms as effective a heat insulator as a covering of fine asbestos one inch thick, it will be understood why the same attention should be paid to the soot-cleaning problem as is paid to the old bugaboo of scale removal. If shipowners realized how much the old "lance" method of cleaning heating surfaces actually costs in dollars and cents, every vessel would be equipped with a mechanical soot blower.

While many of the suggestions which follow may seem like old chestnuts to many old-time operators, nevertheless, the writer has seen so many cases both afloat and ashore where they have been utterly disregarded that he feels that attention should be called to them here. Although individually they may appear to be of little account, nevertheless experience proves that collectively they are a decisive factor in reducing fuel cost.

In the first place, a routine working schedule should be laid out, and nothing short of an emergency job should be permitted to cause a deviation from it. If the work is carried out in accordance with the schedule and is well done, it will be found that there will be less emergency work done. It must be remembered that loss of time at sea runs into money, and if we expect to compete with foreign vessels, this type of loss must be reduced to a minimum.

In laying out a working schedule, first plan to clean each boiler thoroughly—say every sixty to ninety days, depending upon the particular conditions. When the boiler is down, make certain that the check valves, blowdown valves, etc., are examined regardless of whether they have indicated any defects or not. Attention must also be paid to water columns and fittings, for leaky trycocks may very easily be responsible for the needless loss of a few tons of coal a year. Gage glasses should also be replaced at this time, as very likely their thickness inside the packing nuts has been worn down. If not replaced, sooner or later they will let go at sea and the replacing of a gage glass at sea means a drop in steam pressure and a reduction in the revolutions of the engine. The ash ejector should be carefully examined at least once a month. It does not cut up often, but when it does it usually makes things hum.

The same sort of schedule should be applied to oil-

burning equipment. Do not wait for accidents to happen, get there first on the "stitch-in-time" principle. Examine all valve disks at a specified time. If a disk shows signs of wear, replace it.

It is not assumed that an engineer can look after all these minor details personally, but systematic distribution of the stoke-hold work among the water tenders, supervised directly by the second assistant, who is usually in charge of the boilers, will go a long way towards securing the necessary attention to the many small but important details which are so often overlooked. A water tender should be given a certain part of the equipment to look after, and he should be held responsible for this. Assume, for instance, that water tender *X* has, among other equipment, No. 1 boiler. While on steaming watch *X* feels the blow-down pipe back of the valve of No. 1 boiler to discover if there are any signs of heating, which would indicate a leaky valve. He does the same with the water column drains, etc. Assume, for example, that he discovers a leaky blow-down. He now turns to a note book, which may be called the "boiler trouble book," and on the page headed "No. 1 Boiler" he enters the information regarding the leaky valve, together with the date on which it was discovered. This book serves as a record of the work that must be done when the boiler is let down. Oftentimes, unless someone happens to remember it, a boiler will be fired up after overhauling with the try-cocks leaking, simply because the leak did not show when the boiler was "dead."

All the larger valves should be inspected and operated and graphited at a specified time. The fact that this was done should be entered in the log slate. The slate is used not because a record is needed, but because the man to whom this work was allotted is more apt to do it if he has to go on record as having fulfilled his task. The packing, etc., of the smaller valves and keeping them tight should also be divided up in a like manner, and leaky stuffing boxes should be investigated by the man who is detailed for such work in his section. The use of this system, it will be found, eliminates to a great extent the passing of the buck and the "let George do it" spirit.

Another feature well known to any engineer is the desirability of maintaining a fixed water level. It has been the writer's experience that this condition is improved by placing a piece of tape around the glass at the steaming level where it is always in sight. The men should also be made to realize the importance of the functions of the feed water heater.

A record should be kept of the work done and the type of material used, as this record will show the life of the various materials and the time saved by their use. This record, therefore, will serve as a valuable guide in ordering supplies for future use. It is assumed, of course, that a regular log is kept to show up increased efficiency and economy.

While all of the foregoing may sound like additional work, it actually does not result in a lot of extra work. It is simply a method of distributing the work and eventually will involve the use of much less energy.

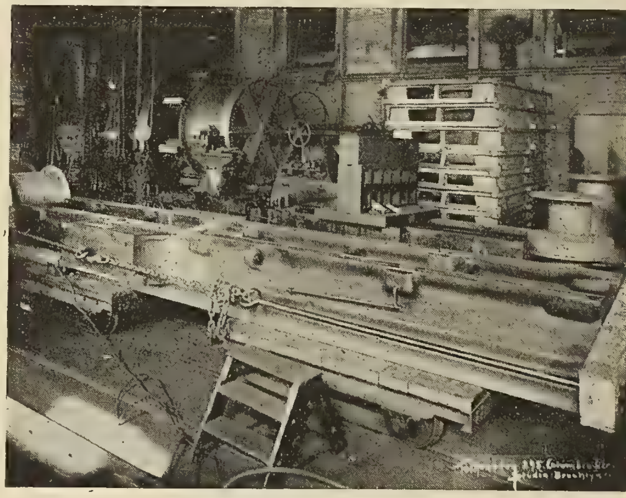
In conclusion, the writer asks the indulgence of those familiar with the methods suggested in the hope that those not so well versed in the subject may benefit from these suggestions. Technicalities have been avoided in order to simplify the subject, and it is sincerely hoped that the American marine engineer will take advantage of every means available for improving the efficiency and economy of the vessels which comprise the new American merchant marine.

Cast Iron Planer Bed Welded

CAST iron offers many difficulties to the welder, and some of the difficulties are incident to the design of the parts welded rather than to the cast iron itself. The job shown in the accompanying illustration is interesting principally on account of the fact that the weld had to be made without appreciable distortion of the parts, and the joint had to be finished so that the weld could not be readily detected.

The job in question relates to a large planer bed 20 feet long and weighing approximately 12 tons. This bed is part of a 60-inch planer and was broken into two parts approximately in the middle. The line of the break was 84 inches, and the welding was done from both the inside and the outside, making an external welding line of 168 inches.

In doing this work it was first necessary to assemble the parts in exact alinement and position. This was done by setting up two long inverted "V's" and laying the planer bed upside down on these "V's"; then the parts



Welded Planer Bed

were drawn together with screws in a huge clamp, as shown in the illustration. Having cut out the joint with air tools, the welding was done according to usual practice, using a steel pencil and special steel reinforcing plates. When finished, the exterior surface was ground flush with that of the original casting, so that were it not for the chalk put on for the purpose of photographing, the weld would be entirely invisible to the eye.

There are two remarkable achievements in this job: first, the absence of distortion and, second, the strength of the joint. The absence of distortion is proved by the fact that the ways were in perfect alinement when the job was completed, and, furthermore, a spiral gear with its bearings, which was located in the middle right adjacent to the weld and incidentally interfered considerably with the welder, was found in perfect alinement after the job was completed.

As for strength, this was tested at two different times—first, when the welding was about two-thirds done it was necessary to turn over the bed. This was done by putting a sling around the middle at the weld and hoisting, which put the maximum strain of the weight of the bed on the weld. During the operation of turning over, the bed was dropped some three or four inches on the floor and was bumped around considerably, all of which put excessive strains on the partially completed weld, and yet there was no sign of weakness. The work was done for the Lidgerwood Manufacturing Company by The Electric Welding Company of America, who employ the weldcraft process.

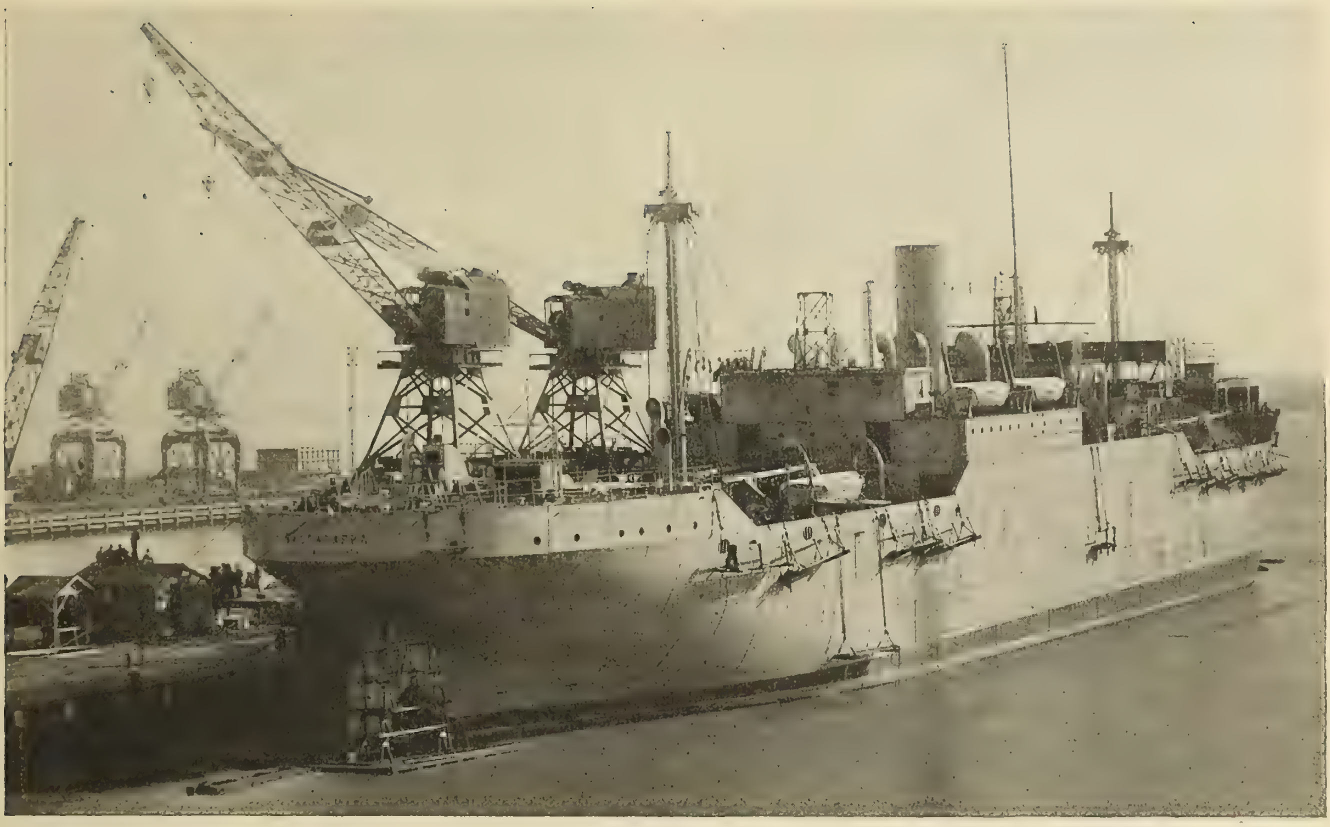


Fig. 1.—Open Pier Equipped with Full Arch Gantry Cranes for Loading and Discharging Ocean-Going Vessels

Pier Design for Ocean and Lake Terminals

BY H. MCL. HARDING*

This article describes plans and designs for piers for marine terminals, and especially for piers to be used by freight-carrying ships. The designs for piers differ materially from those for quays, which were described by the author in a recent issue of this journal.

THERE are many features to be considered in designing a pier which do not apply to quays. Considering these there are differences of opinion which may be called the difference between the rule of thumb practice and uninfluenced engineering principles. The one is derived from a limited or local practice at one port, and the other from a knowledge and study of all ports throughout the world. Among these may be mentioned, width of piers, width of slips, dimensions and location of sheds and often of the piers.

There are also questions in determining the width of sheds in proportion to the width of the piers, types of substructures for sustaining the sheds, the number of sheds on piers, number and height of the stories, number and location of the railway tracks, the railway and dray approaches to the piers, the position and cubical contents of the warehouses, location of the dray roads, length of storage railway tracks and many other features, all of which will be herein treated and the deductions given.

It is the desire that there may be such practical information derived from a study of the facts herein presented that where the conditions are suitable the terminal substructure and pier and superstructure may be planned and designed in accordance with the latest and best terminal engineering practice and free from any prejudice, influence and provincialism.

While there are exceptions to the principles given and also various types of construction, nevertheless it is deemed better to recommend those that after study and practical experience seem to be the best for general adaptation. Such a discussion of terminal engineering should be of more value than to follow a method of giving many examples of different pier design and thereby leave a confusion of ideas as to which should be adopted.

In designing a pier the method of procedure may be as follows:

First, there should be a personal inspection and study of the location, then an examination of existing maps, including those of the Federal government, of the county and city, obtaining full information as to the water currents and prevailing winds, the water elevations above and below mean low water, the types of ships which will use the terminal, possible rail connections—in short, a complete knowledge of all the local conditions; then if there are no physical limitations, the length of the piers is to be determined.

Length of Pier

The width of the piers and the width of the slips depend upon the length of the piers as well as the carrying capacity of the ships, and hence this length must first be

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planned. The longer the pier the wider the pier and the wider the slip, and while there is a certain width of pier and slip for a pier of one unit in length, for a two-unit pier both pier and slip should be wider.

As in the design of the quay unit, there is a pier unit. The pier unit complete consists of the pier, the length of which is made equal to the length of the largest freighter that may there berth or a multiple of that length, sheds, railway tracks and mechanical appliances.

A pier may be of several units in length. The limit of the length of piers is generally the pierhead line of the Federal government. Longer piers can be obtained by designing the piers at an oblique angle to the bulkhead than at right angles.

If, for example, the length of the longest freighter to be there berthed is between 600 and 700 feet, as 625 feet, it is reasonable to suppose that there will be an increase to 700 feet, and therefore 700 feet may be taken as the length of the pier unit. If there should in the future be an increase in length beyond 700 feet, then the pier can be lengthened. It is, however, not advisable to build the unit length of any pier much longer than the probable length of the ship that may be built within some twenty-five years and will use the pier.

For two units the length should be 1,400 feet, or twice 700 feet.

Width of Slip

If the pier should be 700 feet in length, then the width of the slip should be from 280 feet to 300 feet. If the pier be 1,400 feet long, then the width of the slip should be from 325 to 350 feet. If the pier be one unit length, the width of the slip should be four times the beam of the widest freighter that may there berth. As 70 feet, as above, may probably be this width, the slip width has been given as 280 feet to 300 feet, as follows: (25 feet width of barge, 70 feet width of ship, 25 feet width of second barge) $\times 2 = 240 + 40$ feet for working space.

If the pier be of two units in length, then the width should be from 325 feet to 350 feet, or about five times the width of the widest freighter. This is divided up as follows:

From pier to ship, 25 feet, this allowance being for barges, then 70 feet, the width of the ship, then 25 feet for a barge or lighter on the outside of the ship, then 85 feet for passageway of a ship from the inner berth; this would make $(25 + 70 + 25) \times 2 + 85 = 325$ feet. Barges may be wider than 25 feet, so 350 may be taken as the maximum and 325 feet as the minimum

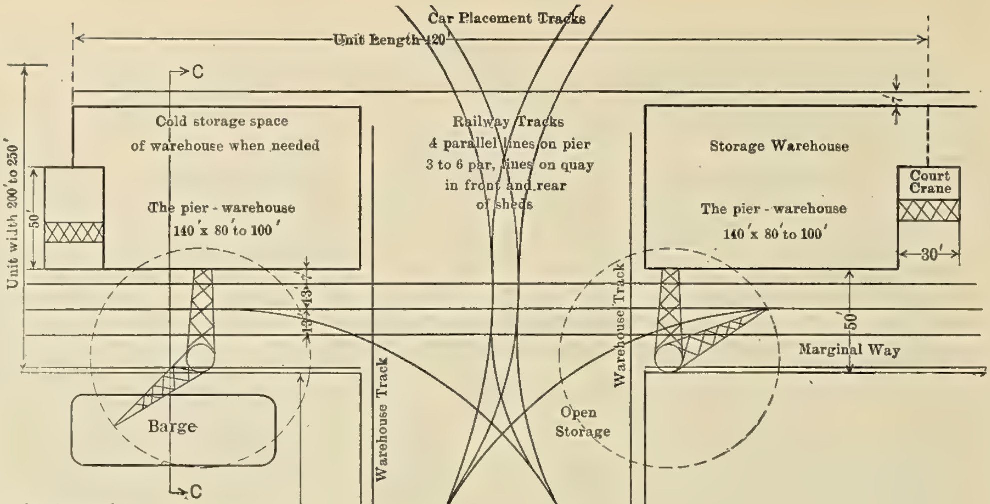
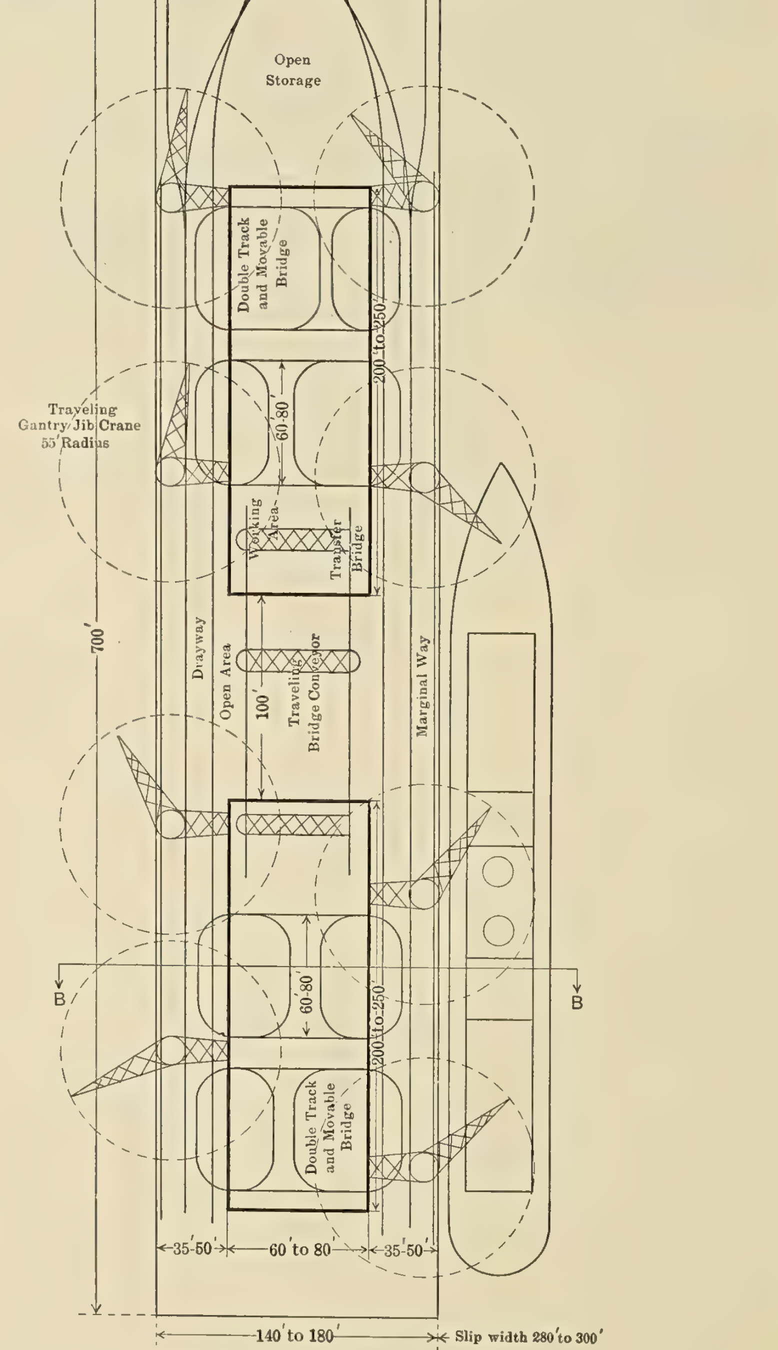

Fig. 2.—Pier Unit Comprising One Pier with Two Warehouses, Two Sheds and Mechanical Appliances for Handling Miscellaneous Cargo

width. The barges may average 100 feet in length; there may therefore be seven barges alongside one ship lengthwise. If there be four ships, the number of barges alongside of four ships would be twenty-eight barges.

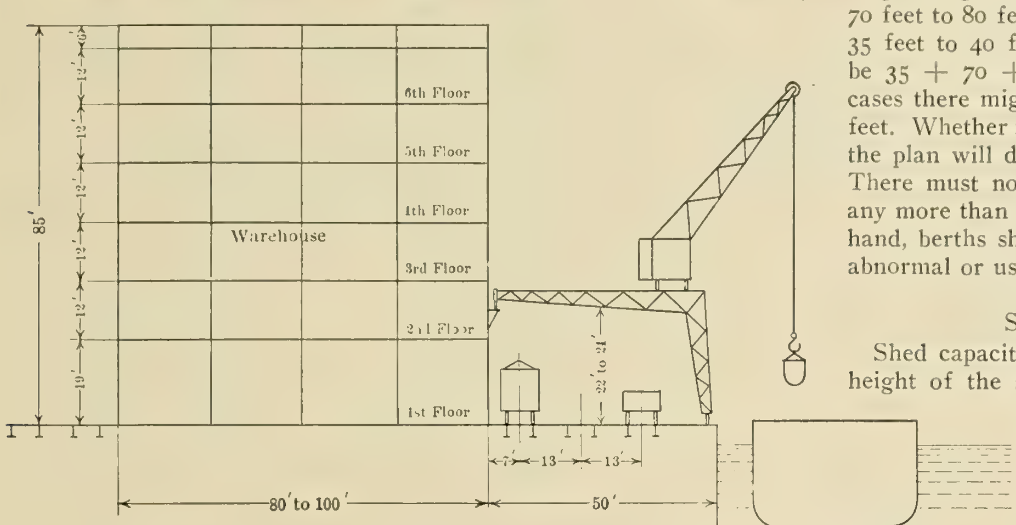

Fig. 3.—Section Through Warehouse with Immediate Waterfront Area (C-C Fig. 2)

It should be possible for the inner barges to move out without moving the other barges which are being discharged or loaded.

The figure of 280 feet to 300 feet as the width of the slip is correct, and will provide berths for many years to come under the assumed conditions. Congestion in the slips should be avoided when possible, although often there are many barges waiting. It is not deemed advisable to make the slips wider on this account.

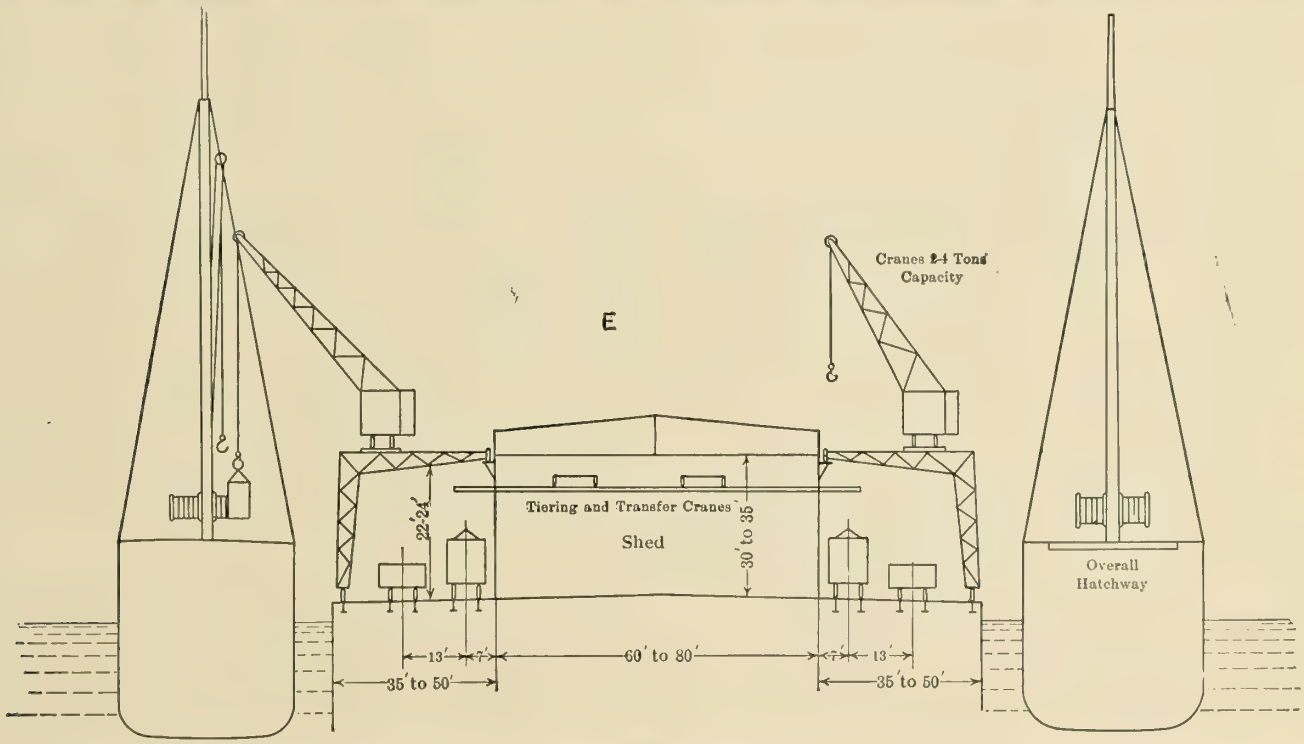

Fig. 4.—Cross Section of Pier (B-B, Fig. 2) Showing Half Arch Gantry Cranes, Transfer Shed with Tiering Machinery and Location of Railroad Tracks

Width of Pier

The width of the pier should provide for railway coordination on each side of the pier and a shed capacity for holding the cargoes of two inbound ships. Outbound cargoes often must be held in the shed for a short time.

For the single unit pier of a length of 700 feet up to 1,000 feet, the width may be 140 feet to 150 feet, divided as follows: From pier edge to shed 35 feet to 40 feet, shed 70 feet to 80 feet, on the other side of shed, 35 feet to 40 feet. Therefore there would be 35 + 70 + 35 = 140 feet. In some cases there might be 40 + 80 + 40 = 160 feet. Whether maximum or minimum width, the plan will depend upon local conditions. There must not be congestion on the pier any more than in the slip; but, on the other hand, berths should not be sacrificed by an abnormal or useless width of pier or slip.

Shed Capacity

Shed capacity is obtained by making the height of the shed below the roof trusses about 30 to 35 feet. This shed has a greater capacity than a two-story shed of equal height. It is in effect equivalent in capacity to a two-story shed, but at about one-half the cost.

On this pier unit 700 feet long, 140 feet to 160 feet wide, there are two sheds each 200 feet long, 70 feet to 80 feet wide and 30 feet to 35 feet clear height below the girders, or 200 feet by 70 feet by 30 feet, giving 420,000 cubic feet capacity. At 80 feet width the capacity would be 480,000 cubic feet per shed; for two sheds, the capacity either 840,000 or 960,000 cubic feet. This represents the gross shed capacity. There are, however, open areas as follows:

Open Areas

It is not advisable to reserve space between the line of the shed and the face of the pier wall for storage, as this should be for the railway tracks and drayways.

There are, however, on a pier of a length of 700 feet,

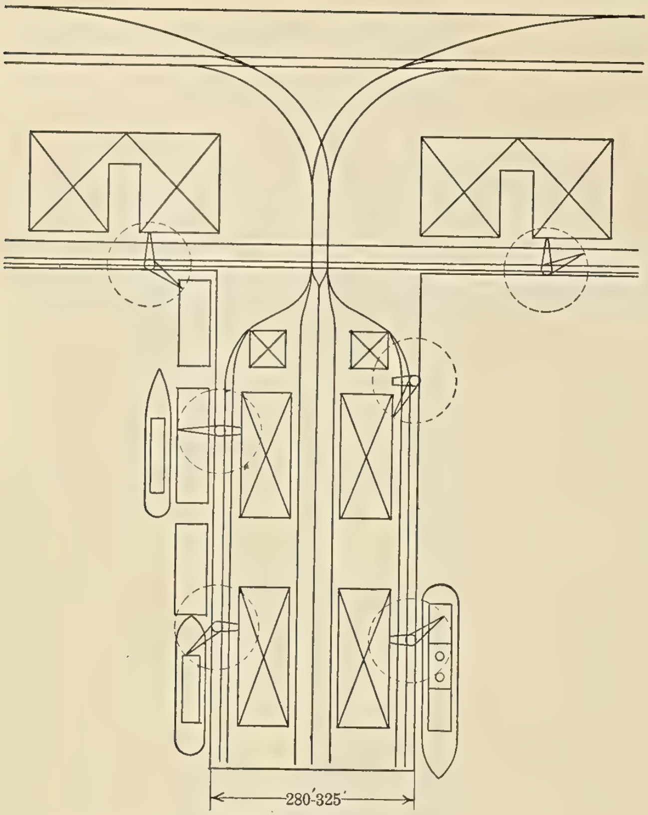

Fig. 5.—Double Pier

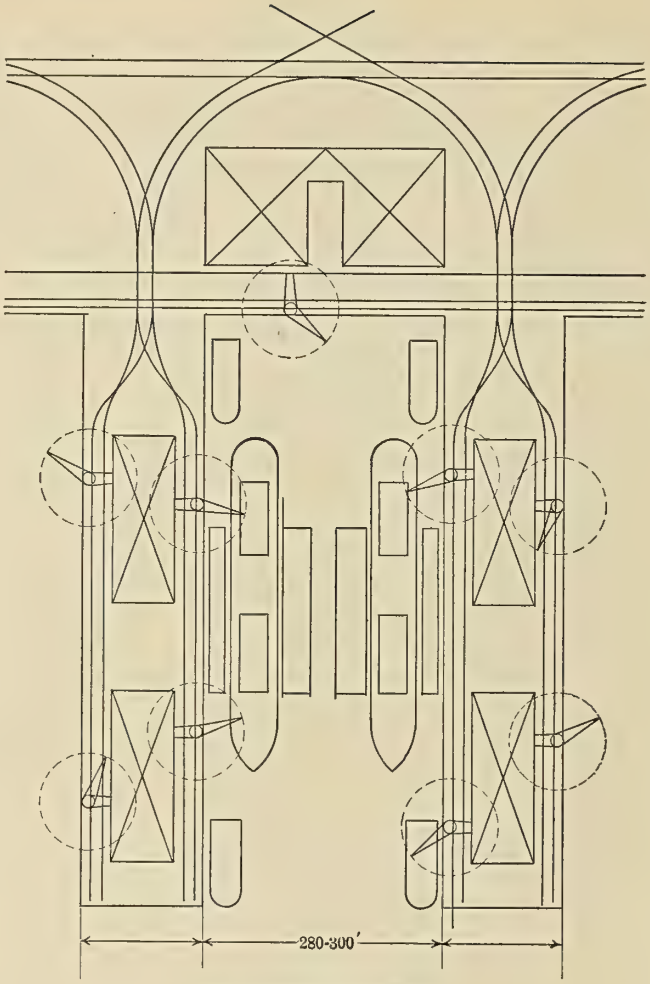

Fig. 6.—Slip Occupation

an open area at the end of about 70 feet by 50 feet, or 3,500 square feet, and between two sheds 70 feet by 100 feet, or 7,000 square feet, and shoreward from the second shed a net area of about 14,000 square feet, making a total of about 24,000 square feet, or about 367,500 cubic feet, tiering fifteen feet in height. This is outside of, and in addition to, the shed capacity.

There is, therefore, over 1,300,000 cubic feet, which is equal to the net cubic capacity of two ships, one on each side of the pier. Making allowances for the freight which is transferred over the side of the ship upon lighters, that which is removed as unloaded by railway cars, drays and vessels, it will be seen that there is sufficient capacity for the forty-eight to seventy-two hours' holding time. During and after this time the cargo is transferred from the shed to the warehouse.

Warehouses

The number of the warehouses can be increased, being located on the lands to the rear of the waterfront. The immediate waterfront or the shed location is limited, but there is generally ample space in the rear for many warehouses.

If the pier should be 1,000 feet in length, then there would be one additional shed and 100 feet additional open area.

Mechanical Appliances

As to the mechanical appliances, those outside of the shed should be universal in character and should be able to transfer all the varied kinds of freight which must be unloaded and loaded at a public terminal.

The traveling gantry jib crane fulfils all the requirements and is generally the type installed. It can serve a larger area without congestion than any other type of unloading or loading machinery, and will be found at most ports where modern machinery is installed. There are over twenty companies in the United States who manufacture and sell these cranes.

Such a crane should have a lifting capacity of 2-4 tons, that is, two tons at 200 feet to 300 feet per minute with one rope, and four tons at one-half this speed. There should be temporary excess capacity of fifty percent. The rotary speed should be from two to three revolutions per minute, and the traveling speed from 200 to

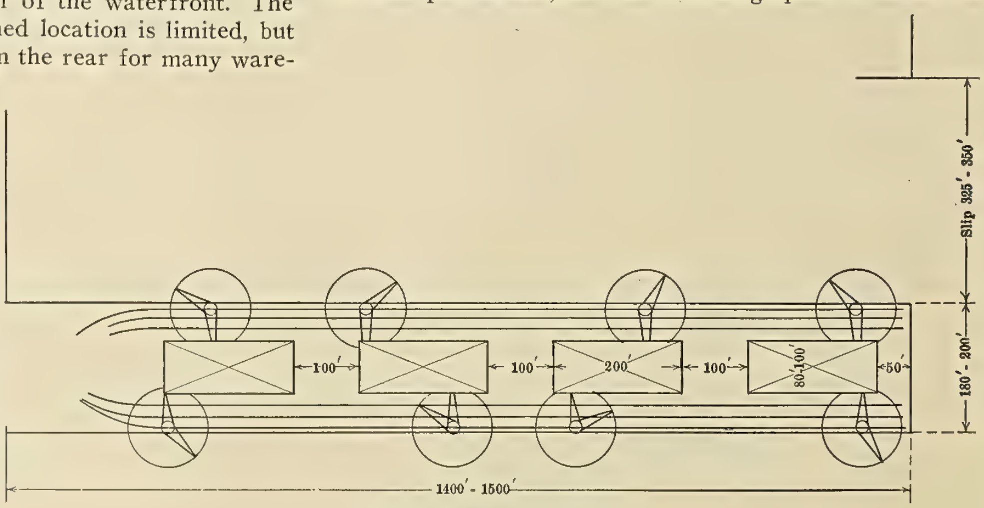

Fig. 7.—Two-Unit Pier

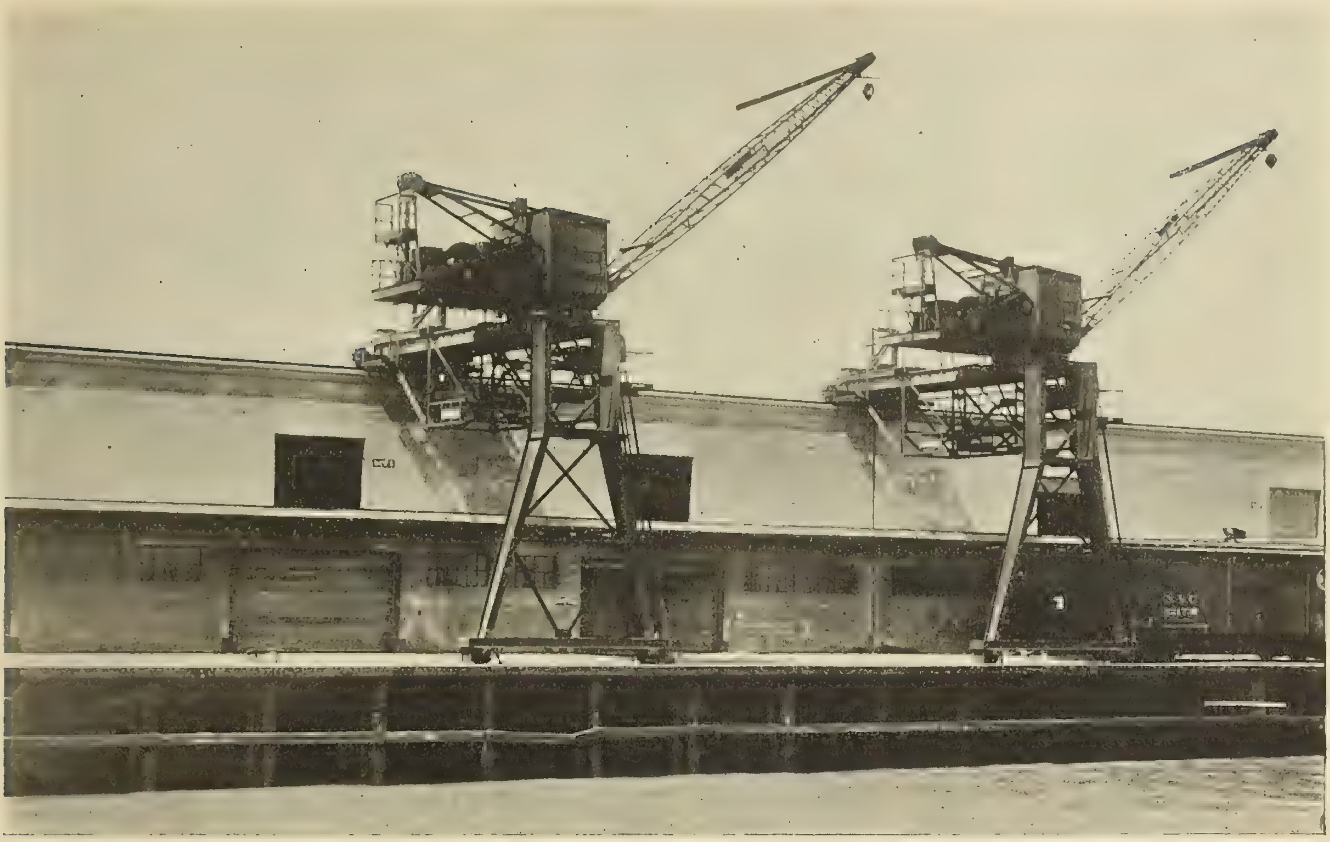

Fig. 8.—Side View of Pier, Showing Shed, Traveling Gantry Jib Cranes and Location of Railway Tracks Between Shed and Side of Pier

300 feet per minute. Two such cranes operating at each hatch, in conjunction with the winches on the ship, will enable wonderful speed of discharging to be attained. The weight of such a crane would be about 50,000 pounds.

To avoid floor congestion in the shed, there should be overhead traveling cranes for assorting, distributing and

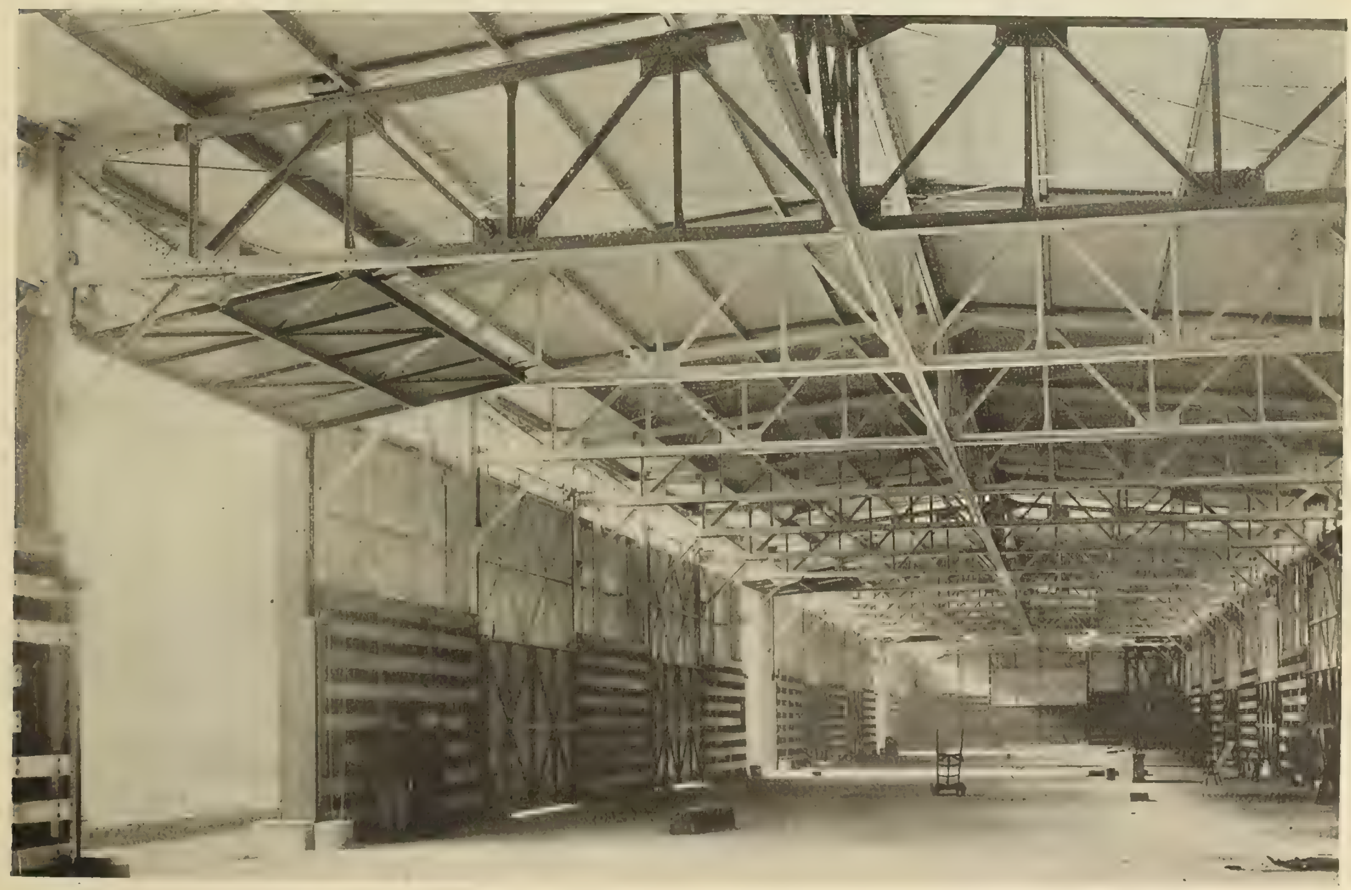

Fig. 9.—Interior of Pier Shed Showing Details of Construction, Methods of Framing and Side Protecting Planking

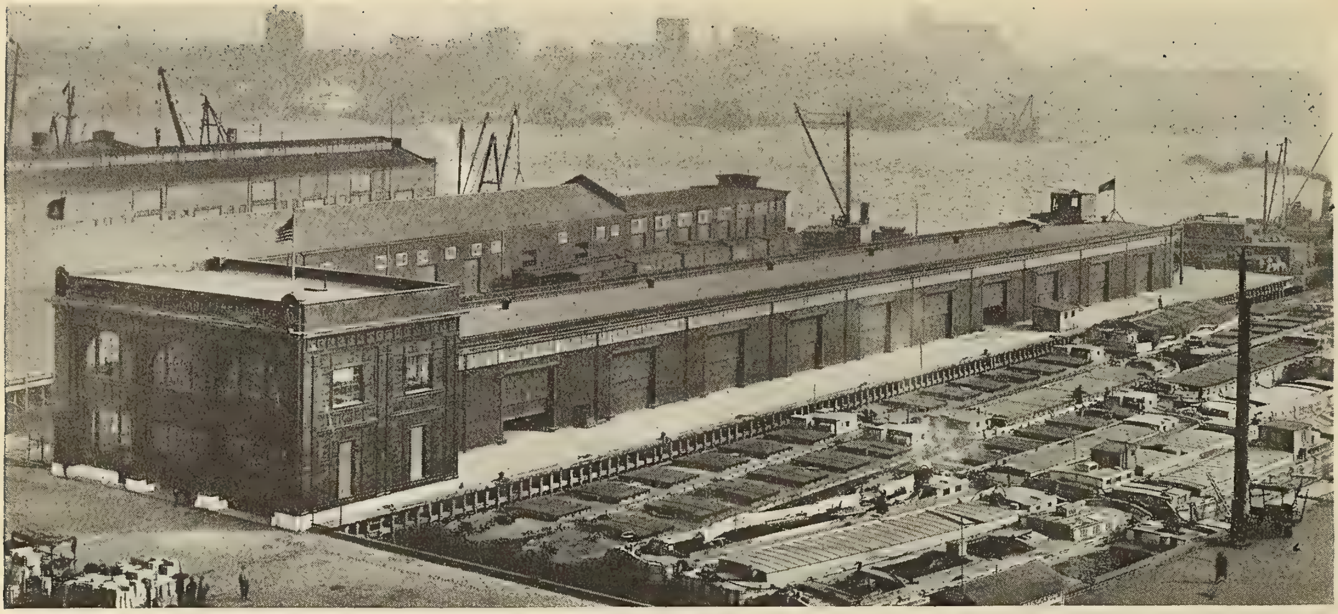

Fig. 10.—Typical Pier Shed Showing Headhouse for Offices, Side Doors and Dray Area Alongside of Shed to Be Spanned by Traveling Gantry Jib Cranes

tiering. The general arrangement of this machinery is indicated in the attached plan and elevation. It will be noticed that provision is here made for transferring freight across the pier.

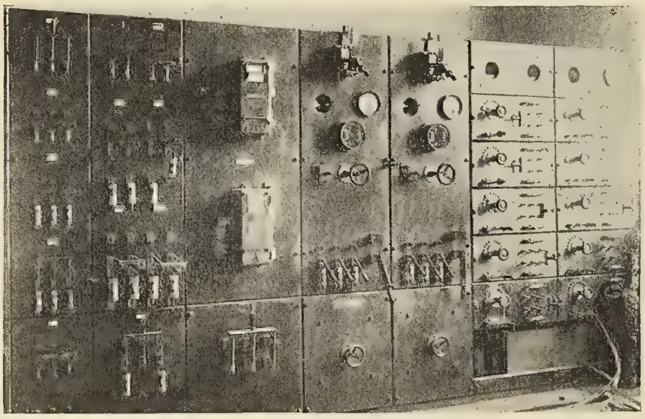

Fig. 11.—Switchboard for Modern Pier Shed. This Board Controls the Lighting of the Shed, the Operations of the Various Gantry Cranes and the Charging of Storage Batteries

CONCLUSIONS

First—Single unit piers about 700 feet long should be 140 to 150 feet wide, with slips 280 feet to 300 feet wide.

Second—Sheds should have large capacity due to high tiering by overhead machinery.

Third—Traveling gantry jib cranes adapted to lifting and swinging miscellaneous cargoes should be installed.

Fourth—Railway tracks should be installed on both sides of the piers, and provision made for drayways.

BRITISH OIL BUNKERING STATIONS.—The rapid conversion of British and American shipping to oil fuel has created a new problem of how to keep these ships supplied with bunkers. Here is the British answer to the problem. A large British oil bunkering company, backed by powerful interests, is being formed to supply fuel to oil-burning ships at bunkering stations throughout the world. The chairman of the new company will be Lord Inchcape, who is a director of the Anglo-Persian Oil Company. Messrs. William Cory and Son, Ltd., will act as selling agents and will be in a favorable position to prepare for the supply of oil fuel to ships at stations throughout the world, through its own organization and the arrangements of the coaling firms it controls. While the rduction in the price of British bunker coal has brought a certain amount of relief to shippers, the problem of securing a sufficient supply of oil fuel for British ships has become acute and is likely to become more so as vessels fitted for burning oil fuel leave the builders' yards in increasing numbers. The new British company is said to be assured of supplies of oil in the East and will no doubt be able to strengthen its position in other directions.

Material Handling Machinery at the New York Electrical Show

PRACTICALLY every type of machine used in handling freight shipments at the steamship piers and railroad terminals will be exhibited at the Electrical Exposition to be held at the Grand Central Palace, New York, in October. These exhibits which are to be a special feature of the show will be presented and demonstrated under the auspices of the Material Handling Machinery Manufacturers' Association, which has spared no pains or trouble in making this big industrial exhibit comprehensive to the last detail. In order to have sufficient room to demonstrate properly small trucks, portable cranes, trailers and so forth, the whole third floor will be given over to this purpose.

This will be the first time that the Electrical Show has specialized to any degree in one particular branch of electrical machinery. Economic conditions in the country, though gradually improving, are still far from their prewar standards, and it is in a measure to help better these conditions through the more general use of electrical industrial machinery that this new policy of the Electrical Show Company has been adopted. Hotel, home and office appliances are to retain the same prominent positions they have always held at the show and they will be featured in the same manner this year as in previous years. The advent of larger machinery will in no way curtail their prominence.

Provisions of the Jones Shipping Bill

After months of hearings and discussion, the United States Senate has passed, on May 21, the shipping bill reported by the Committee on Commerce, of which Senator Jones of Washington is chairman. The bill, as passed by the Senate, was substantially the same as reported out of the committee, the main features of which are outlined in this article. The bill is now in conference with the House members, and it is hoped that early agreement will be reached so that the bill may become a law before the recess of Congress.

THE Jones shipping bill, as reported to the United States Senate by its Committee on Commerce, provides for the promotion and maintenance of the American merchant marine, repeals certain emergency legislation and provides for the disposition, regulation and use of property required thereunder and for other purposes. The purpose of the bill is clearly indicated in the preamble, which reads as follows:

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it is necessary for the national defense and for the proper growth of its foreign and domestic commerce that the United States shall have a merchant marine of the best equipped and most suitable types of vessels sufficient to carry the greater portion of its commerce and serve as a naval or military auxiliary in time of war or national emergency, ultimately to be owned and operated privately by citizens of the United States; and it is hereby declared to be the policy of the United States to do whatever may be necessary to develop and encourage the maintenance of such a merchant marine, and, insofar as may not be inconsistent with the express provisions of this Act, the United States Shipping Board shall in the disposition of vessels and shipping property as hereinafter provided, in the making of rules and regulations, and in the administration of the shipping laws keep always in view this purpose and object as the primary end to be attained."

Shipping Board to Be Enlarged

The bill provides for a Shipping Board composed of seven commissioners instead of five as at present, the commissioners to be appointed by the President by and with the consent and advice of the Senate, two for a term of one year and the remaining five for terms of two, three, four, five and six years respectively from the date of their appointment. Their successors will be appointed for terms of six years. Two of the commissioners will be appointed from the states touching the Pacific ocean, two from states touching the Atlantic ocean, one from the states touching the Gulf of Mexico, one from the states touching the Great Lakes, and one from the interior, but not more than one shall be appointed from the same state. The salary of the members of the Board is fixed at $12,000 per annum.

Sale of Government-Owned Vessels

Provisions for the sale of merchant vessels owned by the Government are contained in section 5, from which the following is taken:

"That to accomplish the declared purposes of this Act, and to carry out the policy declared in section 1 hereof, the board is authorized and directed to sell, as soon as practicable, consistent with good business methods and the objects and purposes to be attained by this Act, to persons who are citizens of the United States except as provided in section 6 of this Act, all of the vessels referred to in section 4 of this Act or otherwise acquired by the Board. Such sale shall be made at prices and on terms and conditions as the board may prescribe, but the completion of the payment of the purchase price and interest shall not be deferred more than twenty years after the making of the contract of sale. The board in fixing or accepting the sale price of such vessels shall take into consideration the prevailing domestic and foreign market price of, the available supply of, and the demand for vessels, freights received and prospects of their maintenance, the cost of constructing vessels of similar types under prevailing conditions, as well as the cost of the construction or purchase price of the vessels to be sold, and any other facts or conditions that would influence a prudent, solvent business man in the sale of similar vessels or property which he is not forced to sell; Provided that no sale shall be made at a less price than the cost at the time of making such sale of constructing vessels of similar types in private yards in the United States, after deducting the depreciation charge against the vessels sold generally allowed in shipping operations."

In the following section the Shipping Board is authorized and empowered, if unable to sell to American citizens after diligent effort to do so, to sell to aliens at such prices and on such terms and conditions as it may determine, except that payment thereafter shall be completed in ten years, such vessels having a deadweight tonnage of not exceeding 6,000 tons, unless such vessels are over ten years of age, as it shall after careful investigation deem unnecessary to the promotion and maintenance of an efficient American merchant marine.

Steamship Lines to Be Established

Section 7 gives the Shipping Board authority to investigate and determine what steamship lines should be established and to put in operation from ports in the United States, or in any territory, district or possession thereto, where adequate terminal connections with rail carriers can and will be made or already exist to such world markets as in the judgment of the Shipping Board are desirable for the promotion, development, expansion and maintenance of the foreign and coastwise trade of the United States and an adequate postal service.

The Board is also authorized to determine the type, size, speed and other requirements of the vessels to be employed upon such lines and the frequency and regularity of their sailings, with a view to furnishing adequate, regular, certain and permanent service. The Board is authorized to sell, and, if a satisfactory sale cannot be made, to charter such vessels of the United States as will meet these requirements, to responsible persons who are citizens of the United States who agree to establish and maintain such lines upon such terms of payment and other conditions as the Board may deem just and necessary to secure and maintain the service desired. If privately operated steamship lines cannot be established in this way, the Board is authorized to operate vessels on such lines until the business is developed so that the vessels can be sold on satisfactory terms and the service maintained or until it appears within a reasonable time that such lines cannot be made self-sustaining.

In the same section authority is given to the Postmaster-General to contract for the carrying of the mails over such lines at such prices as may be agreed upon by the Board and the Postmaster-General. Preference in the sale or assignment of vessels for operation on such steamship lines will be given to persons who are citizens of the United States who have the support, financial and other-

wise, of the domestic communities primarily interested in such lines, if the Board is satisfied of the ability of such persons to maintain the service desired. Provision is made so that the provisions of this section will not conflict with the steamship lines already established, and in the following sections of the bill are prescribed certain duties of the Shipping Board with regard to the promoting, encouraging and developing of ports and transportation facilities and for the investigation of causes of the congestion of commerce at ports and also the important question of water terminals, including the necessary docks, warehouses, apparatus, equipment and appliances in connection therewith, with a view to advising and suggesting the types most appropriate for different locations and for the most expeditious and economical transfer or interchange of passengers or property between the rail and water carriers.

Ship Construction Fund Created

Section 11 of the bill provides for a construction fund to be created from the revenue acquired from the sales and operation of vessels by the Board. The provisions of this section are as follows:

"That during a period of five years from the enactment of this Act the board may annually set aside out of the revenues for sales and operations a sum not exceeding $50,000,000, to be known as its construction fund, to be used in the construction, or in aid of the construction, of vessels of the best and most efficient type for the establishment and maintenance of service on steamship lines deemed desirable and necessary by the board, and such vessels shall be equipped with the most modern, the most efficient, and the most economical machinery and commercial appliances. The board shall use such funds to the extent required upon such terms as the board may prescribe to aid persons, citizens of the United States, in the construction by them in private shipyards in the United States of the foregoing class of vessels. No aid shall be for a greater sum than two-thirds of the cost of vessel or vessels to be constructed, and the board shall require such security, including a first lien upon the entire interest of vessel or vessels so constructed as it shall deem necessary to insure the re-payment of such sum with interest thereon and the maintenance of the service for which such vessel or vessels are built. If there are routes upon which the board deems it highly important to establish service requiring vessels of the kind described in this section, and responsible persons, citizens of the United States, cannot be found to construct the same, the board may construct such vessels out of such fund in private shipyards of the United States, but no contract for such construction shall be let on a cost-plus basis, and when such vessels are sold the board shall require a cash payment of not less than 25 per centum of the purchase price and ample security for deferred payments. Interests on loans made under this section and on deferred payments shall be at a rate not less than 4 per centum per annum, payable semi-annually."

Until sold, all Government-owned vessels shall be managed and operated by the board or chartered or leased by the board, and provision is made for the continuance of the United States Emergency Fleet Corporation, which shall have the authority to operate such vessels. All property other than vessels which have been transferred to the board is to be sold by the board. The board may also create out of the net revenue from operations and sales, and maintain and administer, a separate insurance fund to cover any interest of the United States in vessels either constructed or in process of construction or any plants or materials required by the board.

Foreign Built Vessels Excluded from Coastwise Trade

The Jones bill repeals the war emergency act which permitted vessels of foreign registry and foreign-built vessels admitted to American registry under the Act of August 18, 1914, to engage in the coastwise trade during the war and for a period of 120 days thereafter. In repealing this Act, however, the provision is made that all foreign-built vessels admitted to the coastwise trade under such Act for the full period covered by the Act and which are wholly owned by the persons who are citizens of the United States, and foreign-built vessels owned by the United States at the time of the enactment of this Act, if sold to such persons may operate in the coastwise trade so long as they are owned by such persons.

Exemption from Excess-Profits Taxes

Under the provisions of section 25 of the Jones bill, the owner of a vessel documented under the laws of the United States and operated in foreign trade shall, for each of the ten taxable years beginning with the first taxable year ending after the enactment of this Act, be allowed as a deduction for the purpose of ascertaining his net income subject to the war-profits and excess-profits taxes imposed by Title III, of the Revenue Act of 1918, an amount equivalent to the net earnings of such vessel during such taxable year, determined in accordance with rules and regulations to be made by the board, provided that such owner shall not be entitled to such deduction unless during such taxable year he invested, or set aside under rules and regulations to be made by the board in a trust fund for investment, in the building in shipyards of the United States of new vessels of a type and kind approved by the board, an amount to be determined by the Secretary of the Treasury and certified by him to the board equivalent to the war-profits and excess-profits taxes that would have been payable by such owner on account of the net earnings of such vessels but for the deduction allowed under the provisions of this section, or unless such owner with the approval of the board (to be given only if because of the smallness of the amount involved the board deems it best for the interests of the United States) applies such amount on any mortgage indebtedness due to the United States for the purchase of ships.

Furthermore, this section provides that during the period of ten years from the enactment of the Act any person a citizen of the United States who may sell a vessel built prior to January 1, 1914, shall be exempt from all income taxes that would be payable upon any of the proceeds of such sale, if the entire proceeds thereto shall be invested in the building of new ships in American yards, such ships to be documented under the laws of the United States and to be of a type approved by the board.

It is further provided in this section that the Secretary of the Treasury, the Secretary of Commerce and the chairman of the board are authorized and directed to determine from time to time what shall be allowed for annual depreciation of vessels purchased from the United States, or vessels completed in the United States, since November 11, 1918, in order that the owners of such vessels shall, with respect to the capital cost thereof, be put as nearly as may be on a parity with the owners of ships under the flag of our foreign competitors in the world's carrying trade, and such allowances shall be embraced in the deductions allowed by law in determining the net income subject to income taxes and war-profits and excess-profits taxes.

American Classification for American Vessels

Section 27 of the bill directs all departments, boards, bureaus and commissions of the Government to recognize the American Bureau of Shipping or any other similar organization approved by the board composed of Ameri-

can citizens, chartered in the United States and 90 percent of whose surveyors shall be American citizens, as their agency for the classification of vessels owned by the United States and for such other purposes in connection therewith as are the proper functions of a classification bureau so long as the American Bureau of Shipping or such approved organization continues to be maintained as an organization which has no capital stock and pays no dividends.

Permission is given in section 28 for cargo vessels documented under the laws of the United States to carry not more than 12 persons in addition to the crew. Such vessels are not to be held as passenger vessels or vessels carrying passengers within the meaning of the inspection laws, although this section does not in any way exempt such vessels from the laws, rules and regulations respecting life-saving equipment.

Differential Rates for Imports and Exports in American Vessels

Preferential rates for imports and exports in American vessels are made possible by the provisions of section 30, which reads as follows:

"That no common carrier shall charge, collect or receive, for transportation subject to the Interstate Commerce Act of persons or property, under any joint rate, fare or charge, or under any export, import or other proportional rate, fare or charge, which is based in whole or in part on the fact that the persons or property affected thereby is to be transported to, or has been transported from, any port in a possession or dependency of the United States, or in a foreign country, by a carrier by water in foreign commerce, any lower rate, fare or charge than that charged, collected or received by it for the transportation of persons, or of a like kind of property, for the same distance, in the same direction, and over the same route, in connection with commerce wholly within the United States, unless the vessel so transporting such persons or properties, or unless it was at the time of such transportation by water, documented under the laws of the United States and owned by persons who are citizens of the United States."

The foregoing provisions may be suspended by the Interstate Commerce Commission whenever the Shipping Board is of the opinion that adequate shipping facilities to or from any port in a possession or dependency of the United States or a foreign country are not afforded by vessels so documented and owned but such suspension of the provisions of this section are to be terminated by order of the commission whenever the board is of the opinion that adequate shipping facilities are afforded by such vessels to such ports.

The Way Open for Preferential Duties

Another highly important provision is incorporated in the Jones bill which may be of great advantage to the American merchant marine in its coming struggle to gain its share of foreign commerce. This provision is found in section 37 which reads as follows:

"That in the judgment of Congress, articles or provisions in treaties or conventions to which the United States is a party, which restrict the right of the United States to impose discriminating customs duties on imports entering the United States in foreign vessels and in vessels of the United States, and which also restrict the right of the United States to impose discriminatory tonnage dues on foreign vessels and on vessels of the United States entering the United States should be terminated, and the President is hereby authorized and directed within ninety days after this Act becomes law to give notice to the several Governments, respectively, parties to such treaties or conventions, that so much thereof as imposes any such restriction on the United States will terminate on the expiration of such periods as may be required for the giving of such notice by the provisions of such treaties or conventions."

Marine Insurance

Under section 31 of the Jones Bill provision is made that nothing contained in previous acts of Congress to protect trade and commerce against unlawful restraints and monopolies, or in any anti-trust laws, shall be construed as declaring to be illegal an association entered into by marine insurance companies for the following purposes only: (1) Re-insuring or otherwise distributing or dividing their risks on hulls, cargo or other interests entering into our inland, coastwise or foreign trade; and (2) transacting an insurance or re-insurance business in foreign countries, provided such association is not used in furthering unfair methods of competition against domestic competitors, or is otherwise unfairly restraining trade.

Section 32 of the bill takes up in great detail the question of mortgages on vessels and the protection of the rights of holders of vessel mortgages so that such investments will be more adequately secured. This section includes the provisions of the mortgage bill previously passed by the House.

The remainder of the bill consists chiefly of provisions relating to the rights and welfare of seamen on American vessels.

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Docking a Drydock at the Plant of the Tietjen & Lang Dry Dock & Repair Company, Hoboken, N. J.

INTERNATIONAL
Marine Engineering

Published Monthly by
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The House of Transportation

THE Simmons-Boardman Publishing Company is devoting its entire attention to the field of transportation, the key industry of the world. The prosperity of our country depends upon the construction, operation and maintenance of the railways and merchant marine because it is useless to produce more than its arteries can handle. The present congestion at the seaports, railway terminals and junctions, and the resultant strain on our none-too-plentiful supply of foodstuffs and merchandise, is perhaps the most convincing argument to the average man that the transportation facilities must be enlarged and maintained.

Twenty-five editors, backed by the contributions of the best brains in the country, are constantly at work on our five magazines and four cyclopedias, which cover the railway field. The railways, however, important as they are to our national life, cannot carry our products to foreign shores—that must be done by ships. The construction of our merchant marine—America's greatest industrial achievement of the war—which is only thoroughly appreciated by foreign countries, must go on. If Congress passes the proper legislation, the problem of competition with other countries, both in construction and operation, can and will be solved.

The first step taken by the Simmons-Boardman Publishing Company to aid the construction of the American merchant marine was the compilation of a *Shipbuilding Cyclopedia* which has just been completed. The second step was the purchase of Marine Engineering which was only consummated after the most careful analysis had shown it to be the best magazine in the marine field. It would indeed be hazardous for a firm of less resources to promise an improvement in such a magazine, but it is believed that, by combining the editorial staff of the *Shipbuilding Cyclopedia* with the existing staff of Marine Engineering, this object can be accomplished. Marine Engineering has been very fortunate in securing a contributing staff that is so well known that it needs no introduction to the marine field. Every effort will be made to induce our contributors in America to become more active, and in order that Marine Engineering may be made more international in scope, special attention will be given articles received from our correspondents in Great Britain covering the shipbuilding industry in that country.

Production and Planning

AS the idea of establishing a central planning office with complete control over the entire plant is gradually gaining favor with the shipyards, and as the success of this method of supervision depends upon the system adopted for carrying it out, it must constantly be borne in mind that the principal duty of the planning department is to devise and put into operation a means for reducing the cost of production. It follows therefore that the principal reason for a planning department being one of economy, the criterion of the success or failure of this department is the amount of money it is actually saving.

The tendency of those in charge of work of this nature is, very often, to go too far into detail. Where such is the case, the planning department, instead of speeding up the work, retards it. In any system the paper work involved is expensive, and in order to eliminate this work as much as possible, the system must be simple. Every operation of the system should be carefully analyzed and should, before being adopted, show some value from a practical standpoint. There are many lines of work in a modern shipyard which could be investigated and which would provide some very interesting data from a technical point of view, but with competition becoming sharper, the shipbuilder cannot afford the time or money which necessarily enter into this work.

On page 499 of this issue appears an article by Donald G. Stevens, under the title of "Why is a Progress and Planning Department?", which gives a general outline of the planning department as operated at the Virginia Shipbuilding Corporation. While Mr. Stevens outlines more or less clearly the methods he uses for keeping track of the progress of work, he omits mentioning the methods used for planning and following up the work, ordering and handling material, compiling cost data, etc. It would appear from the aforementioned article that charting the progress of work constituted the chief function of a planning department where, as a matter of fact, the planning is of greater importance because it directly affects the production. By planning the work in detail in advance and by properly following it up through the various shops in the yard until it is completed and installed aboard ship, the planning department is able to co-ordinate the work of the various trades and departments with a view to eliminating lost motion and unnecessary handling. A few well-chosen charts are important and desirable, but it would appear that the number mentioned in Mr. Stevens' article is excessive. The collection, preparation and charting of data is expensive and should be reduced to a minimum.

Production and planning work is a subject of interest to shipbuilders at any time, but particularly the present, and Marine Engineering would be glad to receive articles from those in other yards interested in the success of this method of management.

Location of Machinery

THE fore and aft position of the propelling machinery in a vessel is generally located amidships in ocean practice and aft in Great Lakes practice. The question, however, of where the machinery should be located is not determined by the locality in which the vessel is constructed, but rather by the class of service for which the ship is designed. Naval architects, as a rule, are fully aware of the advantages and disadvantages of the two systems of machinery installation and they do not hesitate to place the machinery aft in the case of oil tankers and colliers that are designed for service on the Atlantic Ocean.

Where the machinery is located aft it follows, with few exceptions, that the propeller will always remain immersed, no matter what the condition of loading of the vessel may be, but it will be found necessary, when the ship is sailing light, to carry a large quantity of ballast well forward for the purpose of keeping the bow down. On the other hand, with the machinery located amidship, the variation in trim under the various conditions of loading will be slight and much more satisfactory sailing qualities in a seaway are to be expected.

The weight of the machinery when located aft will be less because of the reduction in length of the shafting and shaft alley. The number of shaft bearings and supports will be reduced and the problems connected with alinement, etc., will be simplified. Although the weight of the machinery is reduced, the bending moment in the structure of the vessel in hogging condition, particularly when the vessel is light, will be much greater than with the machinery amidships in which a more symmetrical arrangement of weights is secured.

Preferential Export and Import Rates to American Merchant Vessels

THE Jones Bill, which is now under consideration by Congress and which will probably be passed with few modifications, contains, in section 30, constructive legislation of the greatest importance to the successful operation of our merchant marine. Under the provisions of this section the railroads can give export and import rates only to merchandise transported over their lines which is either exported or imported in American-owned vessels. As an example of what this would mean to American shipping engaged in Oriental trades from the Pacific Coast, Mr. R. A. Dean, general counsel of the Shipping Board, in a memorandum to Senator Jones, states that the domestic rate to the Pacific Coast on steel is 61.25 against an export rae of 60 cents per hundred pounds. Under section 30 of the Jones Bill, an American-owned ship leaving the West Coast, and carrying a cargo of steel, would have a differential in its favor against a foreign competitor of $14.50 per long ton. While the amount of the differential will vary with the commodity and the length of the haul, it will go a long way toward offsetting any operating advantages enjoyed by our competitors.

Under the present law the railways can make lower rates on merchandise for export or imports whether carried in American or foreign ships but in providing that these lower rates can be given only, except under certain conditions, to goods exported or imported in American ships, we are simply following a practice that other countries have found to be greatly to their advantage. It is believed that it was by such measures that Germany before the war was able to guarantee sixty percent of her exports and fifty percent of her imports to German vessels. In a like manner Japan was able to prevent American trans-continental railroads from operating their own ships across the Pacific in competition with Japanese vessels.

These preferential rates are not discriminating duties on exports or imports, such as are prohibited in some of our treaties with foreign nations. We may not, for instance, impose a heavier duty on merchandise consigned to one of our ports because it is carried in a foreign rather than an American ship from the country with which we have the treaty. When, however, a vessel belonging to a country with whom we have a favored nation treaty carries a cargo from a country with whom we have not, as, for instance, a cargo from some of the South-American countries to New York, in an English vessel, we can, but do not, impose a preferential duty.

In view of the fact that it is necessary to put our merchant marine on a paying, as well as patriotic basis, the preferential export and import rates section of the Jones Bill should be passed as it is. Should other countries discriminate against us in a similar manner, we would still have the advantage because our average rail haul is so much greater than that in any foreign country.

Load Line

THE Load Line Bill, which is now before Congress, authorizes the Secretary of Commerce to establish by regulations, from time to time, the load waterlines and marks thereof, indicating the maximum depth to which a vessel may safely be loaded. It further directs that the Secretary of Commerce shall appoint the American Bureau of Shipping, or such other corporation or association for the survey or register of shipping as he may select, to determine whether the position and manner of marking of such vessels on the load lines are in accordance with the regulations.

Load lines on vessels as now established by the classification societies are based upon rules approved by the English Board of Trade, under the provisions of the Merchant Shipping Act of 1894. These rules require that the freeboard, or height of the side of a ship above the waterline amidships, shall be sufficient to obtain the reserve buoyancy given in their tables. As the safety of a ship depends on its subdivision transversely by the proper number of watertight bulkheads, as well as on its freeboard, the recommendations of the London Convention for the Safety of Ships at Sea should be given serious consideration in establishing new rules for load waterlines.

LETTERS TO THE EDITOR

Efficiency in Pumping Out a Vessel

Often after a ship is launched the tanks are filled with water for the sake of testing. This water must later be voided from the ship. For this a pump is generally used, which is set near the water to be pumped. The water is forced by this through a hose which runs up through the hatches and over the side. Commonly, the discharge hose is allowed to hang over the side two or three feet and the water falls twenty or thirty feet.

This, to my mind, is a very inefficient method. It does not take much knowledge of hydraulics to see that if the outlet hose be allowed to reach the water level, the head being pumped against is reduced twenty or thirty feet or more, according to the depth of the ship. The saving in power and time by lengthening out the hose would be quite appreciable for an entire ship.

Since every American shipbuilder is endeavoring to economize in every way, I think that this matter should not escape notice.

Groton, Conn. A Shipwright.

Sea Captain Signals Rescuers with Flashlight

Captain Albert B. Randall, master of the U. S. Transport *Powhatan*, which was disabled in a severe storm 200 miles off Halifax, reports that without the electric hand flashlights, which he carried as a part of his equipment, the work of relieving the condition of his vessel after the rescue ships arrived would have been immeasurably more difficult than it was.

The dynamos were put out of commission when the fireroom was flooded, and in consequence the lighting system was useless. There was only enough current from storage batteries to use the wireless for emergency, and when relief came and there was great necessity for communication with the ships, Captain Randall turned in the emergency to the store of electric flashlights that he carried.

He flashed messages in the Morse code and received replies in the same manner. His officers, who were also equipped with pocket flashlights, not only kept up constant communication but were able to find their way about the ship without difficulty.

New York. E. F. Allen.

Welding Copper by the Oxy-Acetylene Process

In an article in the November, 1919, issue by Commander H. G. Knox, U. S. N., on the "Use of Acetylene in Navy Yards," it was stated that among other metals, copper was also successfully welded by the oxy-acetylene process, rolled naval brass having been the favorite filling material, with most of the other brasses and bronzes. This led the author to make the prediction that with intelligent operation the welding of copper may some day almost completely supplant the coppersmiths' art of brazing. But the fact is that copper welded with rolled naval brass as filling material is not welded at all, but *brazed*, and badly brazed at that, as the brittle brass filling does not allow any extensive working of the metal.

At present the welding of copper is not practical, copper being so great a conductor of heat that the piece to be welded would have to be kept on a forge or other suitable apparatus for preheating at a temperature of approximately 1,100 degrees F. while the welding was going on, the process therefore being very costly.

It is of absolutely no use to attempt the extensive welding of copper unless a filling material of at least 95 percent copper content can be used. Properly preheated and kept hot and properly welded, the seam will stand some working; but up to the present time no filling material has been found which will permit the seam to be worked the same as the rest of the material. However, the oxy-acetylene process is very useful to the coppersmith, as many small flanges, branches, bosses and seams can be *brazed* economically in this manner.

Bridgeport, Conn. Arthur J. Rosen,
Coppersmith, The Lake Torpedo Boat Company.

Wooden Sectional Floating Dry Docks

It is with considerable interest that I have read the comment made by Mr. J. Stuart Crandall, of the Crandall Engineering Company, on the article "Wooden Sectional Floating Dry Docks" published in the March issue of Marine Engineering.

From the second paragraph of the comment I would assume that Mr. Crandall takes exception to the statement under the heading "Design and Construction" that "the members of the sections are largely determined empirically and from good practice." Mr. Crandall states that "such design usually results in the size of the members being entirely out of proportion to the stresses they are to carry. Frequently these members are much larger than required, and at the same time the joints and connections so proportioned that they can only develop a fraction of the strength of these timbers." It is agreed with Mr. Crandall that the forces acting on a floating dock are most definite and include the weight of the ship on the keel and bilge blocks, the weight of the dock itself and the upward pressure of the water on the bottom of the dock. For good design, stress diagrams should be drawn up taking these known forces into consideration and the stresses to which each member will be subjected calculated.

Contrary to Mr. Crandall, I am of the opinion that the stresses calculated from the stress diagram for each member cannot be determined with sufficient accuracy to be solely depended upon in the design of these members. The stresses calculated for each member should be used as a guide in proportioning such members, and it will be found that in many cases the size of the member will be governed by the material required to obtain fastenings of sufficient strength. Then, again, the strength of the fastenings can only be approximately determined; so it will be seen that a wooden dry dock designed in accordance with the statement, "The members of the sections are determined largely empirically and from good practice," will result in a dock having ample strength and longevity without any unnecessary weight. This method of proportioning the members has been used in the design of several of the most successful sectional floating dry docks, and the advisability of such design has been borne out by the fact that years of service have failed to impair their capacity, usefulness and earning power. Time is the factor which determines whether or not a dock is properly designed.

In reply to Mr. Crandall's remark that no mention is made of the effect on the ship when being docked in a loose sectional dock due to wide variations in the rates of pumping, I would say that with proper operation the

stresses set up in the ship when docking are no greater than those stresses which the ship experiences when in service. Only gross negligence in dry dock operation would result in causing undue stresses and distortion being set up in the vessel being docked. Mr. Crandall states that no mention is made of the longitudinal trussed sectional dock and the continuous-wing, separate pontoon dock as these types are designed to withstand longitudinal bending moment, thus taking care of irregularities of pumping and inequality of load distribution. This again is taken care of in the loose sectional dry dock by proper operation.

The loose sectional dry dock also has the commercial advantage over the longitudinally trussed and the continuous separate-wing pontoon docks, as in this type it is only necessary to operate a sufficient number of sections to accommodate the vessel being docked. With the two other types, the entire dock must be operated when docking a vessel which is smaller than its capacity. While it is desirable to have a dry dock able to accommodate the largest ships using the port, there is seldom a sufficient number of these ships to keep the dock busy. Thus it becomes necessary to dock vessels smaller than the dock's capacity between times, and it is this condition which is taken care of so economically in the loose sectional floating dry dock.

It isn't so much a question of having a dry dock capable of lifting the largest vessel using the port as it is of having a dry dock that can dock the largest number of vessels.

Hackensack Heights, N. J. CARL E. PETERSEN.

NEW BOOKS

Shipbuilding Cyclopedia

REVIEWED BY PROFESSOR C. H. PEABODY*

SHIPBUILDING CYCLOPEDIA. (A reference book covering definitions of shipbuilding terms, basic design, hull specifications, planning and estimating, ship's rigging and cargo-handling gear, tables of displacement of commodities, arrangement and working drawings of modern vessels, and a composite catalogue of marine equipment.) Edited by F. B. Webster, editor-in-chief; J. L. Bates and S. M. Phillips, associate editors, and A. H. Haag, consulting editor. Size, 8¼ inches by 11½ inches. Pages, 1,160. Folding plates, 61. Illustrations, over 5,000. New York, 1920: Simmons-Boardman Publishing Company. Price, $15, leather; $10, cloth.

A modern steel steamship has so many interrelated conditions and properties that a complete and satisfactory design can be made only after the main dimensions and proportions are known, but these dimensions and proportions are the subject matter of the design. The design of a ship has consequently two stages: first, the rapid selection of the main dimensions and proportion, and, second, the preparation of working drawings and the computation by the scientific department to demonstrate that the ship can be satisfactorily built to the assigned dimensions. The first stage consists in making an intelligent copy of existing ships with required modifications; the second process continues after the actual construction of the ship is well in hand and is often completed after the ship is completed and has had her trials.

In order that the preliminary design may proceed rapidly and confidently, the designer must have at hand codified information concerning various classes of ships. Text-books and handbooks on naval architecture and shipbuilding give such information in a general way; complete information in sufficient detail has hitherto been found only in the archives of the offices of shipbuilding companies; or for naval ships in the bureaus of construction and engineering. A naval architect who has at hand such archives covering large and varied construction with the information properly codified and arranged can design a new ship rapidly and confidently and will seldom if ever meet with disappointment either in the completion of the design or in the performance of the ship in service.

The *Shipbuilding Cyclopedia* presents in a single volume the equivalent of the information found in the archives of the drawing offices of shipbuilding companies. It gives also certain methods for determining dimensions and proportions not hitherto published and much of the material is presented in new forms.

The material of the *Cyclopedia* is presented in six main groups:

(1) Dictionary of terms.
(2) Basic design.
(3) Hull specifications.
(4) Planning and estimating.
(5) Ship's rigging and cargo-handling gear.
(6) Ship plans.

The editor, Mr. Webster, in addition to his responsibility for the complete work, presents the first, third and sixth groups; Mr. Bates is responsible for the second, Mr. Phillips for the fourth, and Mr. Haag for the fifth.

(1) The dictionary of terms in addition to giving definitions and more or less cyclopedic information, gives references to pages in such a manner that it serves as an index to the book.

(2) The basic design by Mr. Bates adapts to merchant ships methods that have been developed in the Bureau of Construction and Repair for the design of warships. Much of that work in the Bureau was done by Mr. Bates, who presents here methods of design that are admirable for their simplicity and accuracy. The reviewer may perhaps be pardoned for going into this matter in some detail because it has excited his interest. The first step in the design of a ship is the selection of the length; a short ship is a cheap ship. At the same time consideration must be given to ease of propulsion. For this purpose Mr. Bates gives five diagrams by aid of which he selects a trial length and studies the effect of variations from that length and so selects the most desirable length for his design.

The second step is the selection of the draft for the ship; in a general way it may be said that a deep ship is a cheap ship. But the draft is likely to be limited by the service of the ship; and a small draft enables a ship to enter many harbors. Associated with the draft is the depth of the ship both as controlling the scantling necessary for strength and the freeboard required for safety. The basic method proposed facilitates the investigation of the effect of variation of draft and leads to an intelligent choice.

A matter of much importance in the design of a ship is the metacentric height. This is likely to receive scant consideration in a preliminary design, but if it be neglected until the complete scientific calculation is made, expensive and inconvenient changes may be forced on the builders to bring it within proper limits. The items entering into the metacentric height are the heights of the center of gravity and the metacenter above the top of the keel. The first depends on the construction of the ship and the arrangements of weights; it can be fairly well determined by comparison with known construction. The second depends on the form of the ship and is therefore

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geometrical and it can be located accurately for any set of ship's lines. Mr. Bates presents curves from which the height of the metacenter can be read from curves, which are published here for the first time. The metacentric height may be controlled in the preliminary design by the selection of the proper beam for the ship. Since the height of the metacenter varies with the square of the beam, a small variation will usually give complete control of the metacentric height.

There are two properties of a ship which stand out prominently, i. e., the displacement and the speed; that is, the power to carry a load and the power to arrive on time. A failure in either is at once evident and inexcusable. The usual method in a preliminary design is to make an intelligent copy of existing practise by the theory of similitude expressed in the form of the admiralty coefficient. This method may be made to yield satisfactory results, but it does not give a ready means of determining the proportions which will give the best performance. Not uncommonly an appreciable advantage may be had by moderate changes in the form of the ship; the best form is sometimes unexpected. It is for the investigation of this matter that experimental towing basins exist, but information from that source is slow and expensive. Perhaps the greatest advance in recent years is that presented by Admiral D. W. Taylor, U. S. N., in his *Power and Speed of Ships,* by aid of which the designer may make a study of the influence of form on propulsion and select the best model for his ship without awaiting the experiments on models which he may think desirable. This great work based on many series of models that have been towed in the naval basin relates primarily to warships; it can be used with facility for many merchant ships, but not for slow freighters. By modifications and extensions, Mr. Bates has adapted this work to the preliminary design of all types of ships and gives curves from which power may be read directly.

Having the main dimensions and proportions for a ship, the lines must be drawn as the basis for the complete computation as made by the scientific staff. These lines are controlled by the proportions to which they must conform. For ready construction of the sections and waterlines a series of diagrams is given based on Admiral Taylor's mathematical method as used in the Navy, but adapted for convenient use with merchant ships.

Passing over with bare mention such important subjects as the coefficient of propulsion as affected by appendage and selection of scantling and computation of strength, we will speak of the matter of freeboard, and especially of the presentation of the report of the "International Conference on Safety of Ships at Sea" of 1913.

(3) The third division of the *Cyclopedia,* by Mr. Webster, furnishes a guide for the preparation of hull specifications. The specifications are divided into groups and are indexed to facilitate reference to any and every item. This section will be found valuable in preparing estimates for bids on proposed vessels and for job orders, and especially as a basis for weight estimates.

(4) The section on planning and estimating, by Mr. Phillips, has to do with the supervision of ship construction in the yard. It deals with ordering material, planning and routing work and estimating cost. Excellent plans are given of such important yards as the Bethlehem Shipbuilding Corporation yards at Fore River, Sparrow's Point and Alameda, and the Baltimore Dry Docks and Shipbuilding Company and the Newburgh Shipyards.

(5) Mr. Haag in the fifth section deals with the very important matter of Ship's Rigging and Cargo-Handling Gear, making a strong plea for standardization as leading to good practice and economy. Methods and materials are represented clearly in detail with much information not readily attainable except by a search through makers' catalogues. There is also given a table of unit displacement of commodities forming common cargoes in merchant ships.

(6) The sixth section gives the equivalent of the information found in the ship plans of many drawing offices conveniently systematized and arranged. There are more than fifty folded plates and more than three hundred pages of illustrations and tabulated information dealing with every type of merchant ship; passenger ships, combination freight and passenger ships, freight ships, tugs and barges; for navigation of the deep seas, inland waters, Great Lakes and rivers; steamers with reciprocating engines or turbines, motorships and sailing vessels. Of a certain freighter there are given ten folded plates and a hundred pages of plates and tabulated data. Other ships are well represented, though with less profusion.

This material is arranged in two groups. The general plans of each ship are placed contiguously in the first group; in the second group the detail working drawings are placed in the order in which a ship is constructed—that is, in natural sequence.

The dictionary at the beginning of the book serves as an index to this section. The section begins with the center vertical keel, together with keel blocks and staging, and goes on with floors, tanks and inner bottom plating and stern framing; with typical and web framing; with bulkheads and shaft tunnel; engine and boiler casing; with decks and deck houses; with auxiliaries and fittings; with bilge and ballast pumping systems and sanitary systems; with smoke stack and ventilation system; with electrical and wireless systems, and with various fittings and appliances, including gyroscopic stabilizer.

The *Cyclopedia* is completed by a catalog section in which is found the only advertisements in the book—normal, sane advertisements such as a naval architect or a shipbuilder will be glad to read and from which needed information can be obtained. Information is the keyword of this section—information that is as much needed as that in the earlier sections. The matter of this section is selected from the catalogues of the various companies represented with their assistance. Proper and informing illustrations are given, but all the text is set in the same style with convenient side headings. The information is given clearly and conservatively, and therefore in a convincing manner.

Various deck fittings, steering engines and other appliances are especially interesting, and it is to be noted that the companies give, in addition to dimensions and capacities, the weights and the centers of gravity—information that is of the greatest direct importance to the naval architect, because there is a strong and almost inevitable tendency towards a rise of the center of gravity of the ship while the ship is being completed or even during service on account of adding appliances on the upper decks. Of like interest is the information concerning anchors and chains and heavy forgings, which indicates that American makers can furnish these essentials sufficient for ships of all sizes. Engines and propellers, of course, belong to the engineering side, but the naval architect is especially interested in engines and propellers that are manufactured in standard sizes. Perhaps this condition arises most notably for Diesel engines and other internal combustion engines, but much the same condition is found with reciprocating engines and turbines of medium power.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Elementary Propeller Design

Q. (1039).—Kindly give list of articles or books which take up propeller design in an elementary manner.

A. (1039).—As previously suggested in this column, the following are very good: "Choosing the Right Propeller," H. H. W. Keith; *Motor Boating,* June, 1911, page 35; "Propellers," by C. H. Peabody, published by John Wiley & Son. In *Rudder* for 1916, pages 460, 499 and 544, are some notes and problems on the design of propellers for motorboats by C. Desmond.

Written versus Verbal Instructions

Q. (1040).—The writer would like to know if written instruction is an efficient way to distribute work to individuals in a squad.
T. M. W.

A. (1040).—Your question is rather vague. Written instructions are proper if it is possible to lay the squad's work out previous to undertaking it. When properly written, they have the advantage of protecting the leading man from claims that the squad members did not understand their duties. If carried too far, written instructions have the tendency of lessening an individual's initiative.

Measuring Pitch of a Propeller

Q. (1041).—Will you please discuss a method of determining the pitch of a built-up propeller after it has been installed upon a ship? If it is not convenient to publish same, please advise where this information may be obtained.
E. R. S.

A. (1041).—There are several methods of doing this, one having been described in this column in April, 1919, page 301. Another very simple method, that of using two plumb bobs or weights hung over opposite edges of a blade while horizontal, is described in *Practical Marine Engineering,* by Dyson, page 608.

Valve Movement by Shifting the Eccentric

Q. (1042).—If a crank shaft 15 inches diameter, with a 5-inch eccentric, is rotated on the shaft ⅛ inch, when the piston is at top or bottom dead center, what distance would it move the valve in the steam chest? (Neglect the angularity of the eccentric rod).

A. (1042).—This same question has been answered in several previous issues, the latest being February, 1919, page 114.

Testing a Condenser

Q. (1043).—On page 97 of your February issue you show, in Fig. 30, a diagram of Westinghouse LeBlanc condenser equipment. You show that the exhaust steam elbow to condenser extends far below the top line of the tubes. How could the steam side of this condenser be tested? It seems to me that the large exhaust steam elbow would have to be removed and the aperture on the condenser shell blanked off in order to get the testing water to cover the top row of the tubes. This would mean a big job every time the condenser is to be tested.
G. W. B.

A. (1043).—The writer would suggest that unless it is positively known that the condenser is leaking badly, the amount of leakage be approximated by shutting all steam off the main condenser. If the circulating pump is run, any leakage can be drawn off by the air pump and tested for salt.

With the exhaust elbow temporarily supported, the bolts in the flange connecting it to the condenser can be removed and a ⅛-inch sheet of steel can be slipped between the condenser and the exhaust elbow and bolted in place. This will serve to blank off the turbine and will not require that the exhaust elbow be taken off. The steam side of the condenser can be filled with water and tested to a pressure of about 10 pounds, preferably by means of a temporary stand pipe. With the condenser heads off, any leaky tubes or stays may be readily found. If no blank flange is used, the turbine could be filled up with fresh water; however, we strongly advise using a blank flange, as it will be unnecessary to drain the turbine carefully by the auxiliary condenser and to jack it over. Furthermore, the chance of leakage or air pockets in the turbine is very great. Care should be taken that water does not come on one side of a valve having steam on the other.

Still another method is to search for any leaks by means of a lighted candle held near all the tube mouths, the air pump being in operation and the condenser heads off.

Corrosion of Boiler Tubes

Q. (1044).—What is the reason why tubes in the watertube boilers blister and then, of course, blow out at that place? This is a common occurrence in ships fitted with watertube boilers.

My experience is as follows: Clean boilers to start with; had a leaky condenser; density went up to 1/32. After six days brought the density down to ⅜ of 1/32; tubes started to blister and blow out. I had one boiler out of four that never gave any trouble.

A. (1044).—Your case is very interesting but not new. There has been recently a number of boilers, both Scotch and watertube, which have required retubing although less than a year old. Because of war emergency conditions it is undoubtedly true that the quality of materials has not been as good as formerly, nor has the inspection been as thorough. The Navy Department has lately put through a number of tests on boiler tubes, and in a paper by W. F. Worthington states that the following agents are responsible: fatty acids, hydrochloric, galvanic action, salty water, carbonic acid, air in feed water.

The feed water especially should be watched. The writer has found cases where the heating coils leaked and drains from the coils deposited oil in the filter tank, no observation tank being fitted.

The density stated in your figures should not of itself be sufficient to cause tube trouble; if, however, coupled with non-homogenous metal in the tubes, electrolytic action might be set up. Especially is this likely to occur if the mill scale has not been removed by pickling in dilute sulphuric acid. The fact that the tubes in one boiler gave no trouble would indicate that they had received entirely different treatment.

A very interesting example of electrolytic corrosion is cited by Mr. E. I. Palmer in the *Journal of the American Society of Naval Engineers,* 1907, page 54, in which it was claimed that copper was deposited in the tubes, appearing in the pit marks. These deposits (about 3 percent copper) seemed to come from the composition blading of the main turbines, the blades showing the effect of erosion. It would be advisable to have a metallurgist compare etched sections of the faulty tubes under the microscope with those of new tubes.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

LONGEST PIERS IN THE WORLD FOR LEHIGH VALLEY R. R.

Part of Gigantic Terminal for Ocean and Rail Freight—Piers to Be 7,000 Feet Long, Giving Six Miles of Dock Space

Quickly following maritime grants by the New Jersey State Board of Commerce and Navigation, the Lehigh Valley Railroad is at work on its proposed immense terminal at Greenville, N. J. Three piers are part of the project, one of which will be finished as soon as possible, the first part to be completed being 3,000 feet long, the total length of each pier being 7,000 feet.

When completed the three piers will provide dock space six miles long, with open and warehouse storage facilities and the most modern machinery for loading and unloading ships, including traveling gantry cranes of the revolving type. Cars will come to ship's side direct, provision being made on the piers, which will be, respectively, 400, 550 and 350 feet wide, for both storage and classification tracks.

Slips between the piers will be 550 feet wide at the pierheads, tapering inshore to a minimum width of 450 feet, a feature which is expected to facilitate handling of ships in and out of the slips, making it possible to navigate the slip channels while other vessels occupy berths on both sides.

The first pier unit to be built will be approximately alongside the Pennsylvania Railroad's Greenville terminal. It is intended to replace the Lehigh Valley's ore dock at Constable Hook, and with the other new piers to supplement the Lehigh Valley docks at Black Tom and at the Tidewater Terminal in Jersey City.

The new development will cover about 635 acres. It is intended to fill in hydraulically, with dredging material, a portion of this area, bringing the shore line along the new project out approximately in a line with the shore line of the Standard Oil Company's Eagle Oil Works, which adjoin the site of the new development on the north. As planned, the piers will extend to the pierhead lines established by the War Department in 1915, which is some distance beyond that established in 1883 by the old Riparian Commission of New Jersey. This will bring the long piers practically to deep water in New York Bay.

The channel now being dredged for the first pier unit will be 300 feet wide, but will be widened as the larger project progresses. The immediate operation requires the removal of 3,600,000 cubic yards of material, which will increase to 12,000,000 yards when the development is completed. The channels will be dredged to a depth of 35 feet at mean low water, making it possible to bring to the docks ships of the largest size. The first pier unit will accommodate two 600-foot 20,000-ton ships at the new ore dock, two more at the warehouse dock and a fifth at the open dock.

$4,000,000 OCEAN LINERS FOR PACIFIC STEAMSHIP COMPANY

Admiral Line to Have Two Great Passenger Carriers for Coast Service Out of Seattle

Announcement has been made that the Pacific Steamship Company, of Seattle, has perfected plans for the construction of two ocean liners to cost approximately $4,000,000 each, which will be put into the service of the Admiral Line of steamers between Puget Sound and California ports. This action on the part of the company has been caused by the refusal of the War Department to consider the disposal of the army transports *Great Northern* and *Northern Pacific,* and the sale of the steamers *Yale* and *Harvard* to a Los Angeles concern.

The ships are planned to be the last word in passenger liners, and they are to be built at the earliest possible moment. Full details of their construction will not be given out, it is said, until the contracts have been let. These contracts will not be placed until the Pacific Steamship Company has carefully considered every bid, especially tenders for the work which will be made by Pacific Coast yards, as well as builders on the Atlantic coast, who have been invited to submit bids. It is understood that the preference will be given to Pacific Coast yards, other things being equal, but in case the contracts come to the Atlantic coast the company plans to run a big excursion when the steamers are launched, from New York to the Pacific by way of the Panama Canal, with stops at San Pedro, San Francisco and Seattle. Present expectations by the company are that eighteen months will be required for the construction and equipping of these vessels, which indicates that no pains will be spared to make them floating palaces. It is hoped by the company that they will be able to have them in commission and operating out of Seattle by January, 1922.

Steward Gear Stands Test

The Steward Boat Release Gear is guaranteed to meet the approval of the British Board of Trade, United States Steamboat Inspection Service, Lloyds, American Bureau of Shipping, and all other classification societies, both in this country and abroad.

It is believed that this is the only all-American release gear backed by such a guarantee.

In a recent test conducted by the British Board of Trade the following procedure was carried out with a 30-foot boat with a load of 6.89 tons:

The boat was hoisted to the lower bridge rail and lowered again with jerks until water-borne and then released; one end of the boat at a time was hoisted clear of water and then released; the boat was hoisted clear of water (not water-borne) and then released; towed with both tackles hooked and then released, and towed with one tackle hooked and then released.

This test is a very severe one, and it is felt that a releasing device properly functioning under it is worthy of the attention of the shipping industries.

George A. Armes, president of the Moore Shipbuilding Company, of Oakland, Cal., is in Europe with a staff of engineers making a study of Diesel engine construction, with a view to securing a license and building these engines at the Moore plant. Two steamship companies have signified their intention of placing orders for new tonnage with the Moore Company as part of their building programme.

DOULLUT & WILLIAMS TO EXPEND $2,000,000 ON PLANT

New Orleans Concern Will Have Immense Fabrication Building, and Repair Shops and Yards

According to an announcement from New Orleans the Doullut & Williams Shipbuilding Company is preparing to expend $2,000,000 in enlarging its present facilities at the Lake Ponchartrain entrance of the Industrial Canal, and making an immense ship repair plant, with two floating docks of 10,000-ton capacity, and a shop for the fabrication of steel for bridges, buildings and barges as well as large ocean-going steamships. Steel vessels now under construction at the big plant will be completed and work on others started.

Horace Williams, secretary-treasurer of the company, speaking of the plan, said:

"The company intends to continue with the construction of vessels of the 9,000-ton deadweight class and larger. We will construct barges and tugs, and fabricate steel for all classes of structures in addition to operating the ship repair plant. The addition of a ship repair plant such as is contemplated will put New Orleans in the forefront of Gulf and South Atlantic ports, in so far as facilities for handling work of this nature are concerned."

The present plant of the company consists of four sets of ways, each 500 feet long, built continuously in such a manner that any length hull can be constructed without changing the ways. There is an outfitting dock at which four vessels can be handled simultaneously; a fabricating shop, machine shop, sawmill, three warehouses, rigging loft, large power house, cafeteria, office building and some four miles of yard track. The site of the plant comprises some 65 acres, which were built up by the use of hydraulic dredges, the removal of material also providing deeper water.

SHRINERS HAVE A SHIP

Harriman Yard Launches the Salaam After a Parade

The Shriner ship *Salaam* was launched April 24 at the Merchant Shipbuilding Corporation yard, Harriman, Pa. The brilliant uniforms of Shriners from three cities lent an Oriental touch of color to the scene, and about 1,000 persons witnessed the parade that preceded the launching.

The steel cargo vessel, named in honor of the war work of Salaam Temple, A. A. O. N. M. S., Newark, N. J., was sponsored with champagne by Mrs. Miles W. Beemer, wife of the illustrious potentate of that temple. Members of Lu Lu Temple, Philadelphia, and of Crescent Temple, Trenton, N. J., took part in the ceremony.

In the parade were the shipyard's kiltie band and its well-drilled firemen and guards, and Boy and Girl Scouts of Harriman and Bristol. The sponsor's party included G. K. Nichols, of the Emergency Fleet Corporation; W. T. Wilson, works manager and a member of Salaam Temple, and Mrs. Wilson, Mr. and Mrs. E. S. Fancher, J. V. Donahue, E. L. Fries, Edward S. Breen and H. W. Egner, Jr.

The *Salaam*, an 8-000-ton vessel, is the twenty-eighth of forty ordered by the Government. It brought the yard's total launched tonnage to 225,000.

Bayles Yard in New Hands

The New York Harbor Dry Dock Corporation has taken from the Shipping Board the Bayles Shipyard at Port Jefferson, L. I., and on June 2 will send a 3,500-ton ship down the ways. A short time ago the 1,200-ton tanker *Anahuac*, which was built at the yard for the Nyack Shipbuilding Company, was launched. The vessel is of 7,000 barrels capacity, 180 feet long between perpendiculars, 31 feet molded breadth and 16 feet depth.

New Refrigeration Machinery Supply House

The new building of the Shipley Construction & Supply Company, on Second avenue, Forty-first to Forty-second streets, Brooklyn, N. Y., is one of the largest supply houses in the world devoted exclusively to furnishing machinery, apparatus and supplies to ice-making and refrigerating plants. They now have about 3½ acres of floor space.

The warehouse is stocked with a complete line of supplies and equipment for the ice-making and refrigerating plant, including a line of York refrigerating machines up to 30 tons capacity. During the last few years the company has equipped many ships with refrigerating plants, hence they have certain departments of their new shops specially for doing marine refrigerating work. Their location is ideal for this work, being within a city block of the Bush Terminal, with their own railroad sidings.

The Shipley Construction & Supply Company is the New York, foreign and marine representative of the York Manufacturing Company, of York, Pa. They have branch offices and stock houses in Albany, Rochester and Buffalo, N. Y., and New Haven, Conn., also agencies in practically all of the larger foreign countries.

$1,500,000 DOCK MERGER

Iron Works and Shipbuilding Company Consolidate

The New Orleans Dry Dock & Shipbuilding Company, of New Orleans, and the Johnson Iron Works have been consolidated, the deal involving $1,500,000. The new name of the concern will be the Johnson Iron Works, Dry Dock & Shipbuilding Company, Inc. The Johnson Iron Works has been in the marine repair business in New Orleans for sixty years, and the drydock company has been established for fourteen years.

Management of the new company will be in the hands of Wilmer H. Johnson and Warren Johnson, who have directed the affairs of the Johnson Iron Works for many years.

The plants of the two companies include a total of 1,750 feet of river frontage on the west bank of the Mississippi River, immediately below the Canal street ferry landing. The plants virtually adjoin each other. The new company will also operate the shipbuilding plant on Bayou St. John, where the Johnson Iron Works has been building tugs for the Government.

The New Orleans Dry Dock Company's three drydocks will pass to the new company. No. 1 drydock has a capacity of 5,000 tons, No. 2 is of 2,000 tons capacity, and No. 3 is a smaller drydock used for river boats and tugs.

WILL CUT LAKE TRAFFIC

Seamen's Act Blamed for Restriction Service

Announcement comes from Detroit that many lake ports, including Toledo, Sandusky, Put-in-Bay, Port Huron, Oscoda, Rogers City and Cheboygan, will lose a great part of their passenger and freight steamboat service this season.

Some of the ports will be abandoned altogether, owing to the action of the Detroit & Cleveland Navigation Company in restricting service on the Mackinaw division, and the removal of the steamer *Frank L. Kirby* from the Detroit and Sandusky run.

The La Follette seamen's act is blamed.

During the season of 1919 the line just about broke even, notwithstanding the fact that all lake lines enjoyed the largest business in their history, according to A. A. Schantz, president and general manager of the Detroit and Cleveland lines.

The company will operate the steamers of the Mackinaw division between Detroit, Alpena, Mackinac Island and St. Ignace this season, cutting out the stops at Toledo, Port Huron, Oscoda, Rogers City and Cheboygan. The boats will only be operated during the height of the season, from June 15 to September 15. If this plan proves unprofitable the line will be abandoned.

The Ashley & Dustin Line has definitely abandoned the freight line to San-

dusky and the Lake Erie islands, and President Dustin declares that the seamen's act is the chief agent in causing the difficulties of the line, formerly a big money-maker, which in late years has operated at a loss.

It is reported that the Arnold line, which operated boats between Mackinaw and the Soo in past seasons will abandon the line this year.

Launches First Fruit Steamer

On Saturday, May 8, the Standard Shipbuilding Corporation launched, at its Shooters Island yard, the first of two fruit steamers for the Cuyamel Fruit Company, of New Orleans. Miss Josefa Juvé, sister of the first vice-president of the Standard Company, named the ship *Hibueras.*

This vessel is a special type combination passenger and cargo steamer, and is 235 feet long, with a 34-foot beam and 16-foot depth. She has accommodations for thirty passengers and will have a speed of 11 knots. This steamer and a sister ship, being finished, will be used in the fruit trade with the West Indies. These steamers are being built under the supervision of William Gardner & Company, naval architects and engineers, of 1 Broadway, New York.

Besides these fruit steamers the Standard Company is constructing four 8,400-ton oil tankers of the "Gold Shell" type for the Eagle Oil Transport Company, of London.

Consolidated Launches an Express Cruiser

An 80-foot express cruiser, being built for Mr. John W. Kiser, of New York City, by the Consolidated Shipbuilding Corporation, was launched at their yards, Morris Heights, New York City, on May 7. Mrs. John W. Kiser was sponsor for the yacht, which was named *Fillette.*

The *Fillette* is 80 feet long and has a beam of 13 feet. The propelling machinery consists of two eight-cylinder 200-horsepower each Speedway motors. The deck accommodations are well appointed, and the interior arrangement is exceptionally attractive; when completed this boat promises to attract considerable interest throughout the yachting fraternity.

The launching of this new cruiser adds one more to the large number of handsome yachts to be delivered by the Consolidated people this year.

Oceanic's House Flag

The Bureau of Navigation of the Department of Commerce gives the description of the house flag of the Oceanic Steamship Company, of San Francisco, which was registered recently, as a white rectangular field having a red stripe around its periphery and a blue ring superimposed in center within which is a red five-pointed star, each point touching the inner circumference of the ring.

AMERICAN YARDS LOSE LEAD, SAYS LLOYD'S REGISTER

First Quarter of the Year Shows British Yards With a Margin of 821,000 Tons—American Ships Average Larger

The world's shipyards are building a greater volume of seagoing tonnage to-day in the shape of steel steamships than ever in their history, says a statement recently issued by *Lloyd's Register of Shipping,* giving returns from all maritime countries. Steel steamers under construction for the quarter ended April 1 are reported to have aggregated 7,692,000 gross tons, as compared with 4,935,000 tons at September 30, 1918, and 7,504,000 tons at September 30 last, the last named being the high record until the quarter just ended.

The total tonnage of all kinds under construction shows a decrease, however, the aggregate being 7,941,000 tons, as against 8,048,000 tons on September 30, 1919. This is accounted for by the progress of the Shipping Board's programme towards completion and the marked decline in the building of wooden steamers. Only 105,000 tons of this type of construction are under way, as contrasted with 1,324,000 tons just before the armistice, since which time there has been a steady falling off.

Great Britain in First Place

Figures for the first quarter of this year show that Great Britain now holds the lead in shipbuilding over the United States by a margin of 821,000 tons, although this country led by 1,930,000 tons a year ago. At the beginning of this year the two countries were neck and neck, the advantage being only slightly with the United Kingdom. The following table shows how the two countries have stood relatively at the ends of the various quarters in the total of gross tons under construction:

	United States	United Kingdom
Sept. 30, 1918......	3,382,000	1,746,000
Dec. 30, 1918......	3,645,000	1,979,000
Mar. 31, 1919......	4,185,000	2,254,000
June 30, 1919......	3,874,000	2,524,000
Sept. 30, 1919......	3,470,000	2,816,000
Dec. 31, 1919......	2,966,000	2,994,000
Mar. 31, 1920......	2,573,000	3,394,000

This includes all types of tonnage. In the construction of steel steamers the margin is a wider one. At September 30 last the United States still led by 279,000 gross tons; but by the end of the year the United Kingdom had a lead of 334,000 tons, and has now extended it to 961,000 tons.

American Ships Larger

But while Britain is building a greater number of steel steamers and a considerably greater aggregate tonnage than this country, the average size of her ships is considerably smaller, her 814 of 3,379,000 gross tons, averaging only 4,151 tons, as against 5,373 tons for the 450 American ships of 2,418,000 tons.

In the United States more tonnage of all kinds is being built in the shipyards of the Atlantic coast than in those of the Gulf ports, the Great Lakes and the Pacific Coast combined. In steel steamers the difference is even more marked, nearly 60 percent of this type of construction being under way along the Eastern seaboard. The following table shows the distribution by districts in gross tons:

	All Types	Steel Steamers
Atlantic Coast	1,602,167	1,585,827
Gulf Ports	213,193	180,793
Great Lakes	173,375	173,375
Pacific Coast	584,563	478,163
Total	2,573,298	2,418,158

A year ago the United States was building nearly 54 percent of all the tonnage under way in the world, as compared to 29 percent for the United Kingdom and 17 percent for all other countries. To-day this country is constructing 32 percent, against about 43 percent for Great Britain and about 25 percent for all other countries. Excluding Great Britain, however, America is building 80,000 tons more than all the other countries combined.

Japan Loses Third Place

Between them the United States and the United Kingdom are turning out three-fourths of the world's tonnage, and no other country is within measurable distance of either of them. Japan, which had held third place from the time of the armistice to the beginning of this year, has now been passed by both Holland and Italy, and is being pressed by France. All three of the latter made gains during the last quarter, while Japan fell back from 309,000 tons to 285,000.

The distribution of shipbuilding at the beginning of April, as compared with the previous quarter, was as follows, in gross tons:

	Mar. 31, 1920	Dec. 31, 1919
United States	2,573,298	2,966,515
United Kingdom	3,394,425	2,994,249
Canada	169,623	188,375
Other Dominions	61,636	63,105
Belgium	25,640	26,293
Brazil	5,366	......
China	35,325	35,700
Denmark	114,851	100.335
France	240,225	216,775
Greece	1,500	1,500
Holland	366,581	328,338
Italy	355,241	314,547
Japan	285,676	309,474
Norway	90.449	92,719
Portugal	5.210	5,210
Spain	98,351	107,463
Sweden	118.553	110,765
Total	7,941,950	7,861,363

Of the total tonnage being built in the world at the beginning of April, excluding vessels the construction of which has not actually been commenced, and excluding all vessels of less than 100 tons, the total under inspection by *Lloyd's Register* amounts to 4,965,612 gross tons.

PORTABLE ELECTRIC PLANER

An Adjustable Tool for Flat or Curved Work

In speeding up the wooden ship and submarine chaser building programme during the war, the Universal planer was developed to replace the jack plane method of finishing the sides and decks of ships. The device was found to be so practical in this connection that it has

Planer in General Use

been improved and placed on the market by the United States Electric Company, New London, Conn.

Some of the features of the device are its ease of operation, which requires no special training. Adjustments are made by means of special hand screws to control the thickness of the shaving. The

Planer on Curved Surface

base of the plane may be curved to suit the surface being worked upon, and this, together with the high cutting speed of the knives, insures a smooth and fair surface. The knives may be easily changed, and will cut hard or soft wood equally well. Motors are available to suit all currents, and the average power required is about 600 watt-hours. The plane may be connected to any electric light socket.

$178,835,000 IN NEW SHIPPING CONCERNS FORMED IN APRIL

Twenty-Two Concerns of $50,000 or More Incorporated—One for $150,000,000—Month Makes New Record

The April showing of incorporations of shipping, shipbuilding and allied interests, makes the largest aggregate of any one month since the war began, and brings the total for the first four months of 1920 above that for the whole of 1919, which stood as a record year in the *Journal of Commerce* compilation of these statistics.

The feature of the month's record was the organization in Delaware of the Garland Steamship Corporation, to take over the New York company of the same name. The new corporation has an authorized capitalization of 1,500,000 shares of no par value, 641,000 shares of which are to be distributed to stockholders of the British-American Tobacco Company. For the purposes of inclusion in the compilation the shares of this company are assigned a value of $100, which is the customary value of stock where a par value is given. On this basis the company contributes $150,000,000 to the monthly total.

The indicated investment in new enterprise of this character during January-April, 1920, appears as $350,370,000. This compares with $25,601,000 in the corresponding period of last year and with $324,123,000 in the entire twelve months of 1919. The average monthly indicated investment to date this year figures out as $87,592,500, against an average during 1919 of $26,967,750. The average per company in April was $8,128,864, compared with $2,945,237 in March, $1,363,530 in February, and $2,384,531 in January.

The indicated investment in new shipping enterprises during the periods indicated is shown in the following table:

August, December, 1914	$1,844,000
Year 1915	37,062,000
Year 1916	69,406,000
Year 1917	271,503,000
Year 1918	120,353,000
Year 1919—	
January	7,525,000
February	6,400,000
March	9,276,000
April	2,400,000
May	17,200,000
June	55,550,000
July	42,485,000
August	55,950,000
September	40,870,000
October	23,405,000
November	52,700,000
December	10,362,000
Total	$324,123,000
Year 1920—	
January	$76,305,000
February	33,380,000
March	61,850,000
April	178,835,000
Total four months, 1920	$350,370,000

Thirteen companies were organized during the month with an authorized capital of $1,000,000 or greater. This compares with twelve of similar proportions launched during March, seven in February and ten in January. The following list comprises names, State of incorporation and authorized capital of shipping companies organized in April:

Armenia Steamship Co., Del.	$1,500,000
Ardmore Steamship Corp., Del.	200,000
Atlantic & Gulf Transportation Co., Del.	1,000,000
Blue Star Navigation Co., Del.	1,000,000
Chillicothe Navigation Co., Del.	300,000
Columbia Dry Dock & Engine Corporation, Del.	7,000,000
Commerc'l Steamship Co., The Del.	500,000
Coosa Steamship Co., Del.	500,000
Dolphin Line, Inc., N. Y.	75,000
East Port Steamship Co., Del.	1,750,000
French-American Line of New York, N. Y.	5,000,000
Garland Steamship Corp., Del.	150,000,000
Haybron Steamship Co., Ltd., Del.	100,000
Hull-Pope-Yott Corp., Del.	110,000
Jeannette Steamship Co., Del.	2,500,000
Livermore, Rojas & Co., Inc., Del. (own and operate)	2,500,000
Monongahela Navigation Co., Del.	400,000
Moshulu Navigation Co., Ltd.	400,000
Neuse Steamship Co., Del.	1,000,000
New Hamburg-American Line of New York, Inc., N. Y.	1,000,000
Ocean Navigation & Transportation Co., Del.	1,000,000
Oconee Steamship Co., Del.	1,000,000
Total	$178,835,000

Royal Belge Buys More Ships

The Lloyd Royal Belge has acquired ten more freighters of the 4,000 tons gross type from the Shipping Board. This brings the fleet of the company up to a total of 84. The vessels, with their new names under the Belgian flags, are: *Knight Island* (*Devonier*), *Long Island* (*Argentier*), *Staten Island* (*Spartier*), *Shelter Island* (*Livonier*), *Fisher Island* (*Ionier*), *Piqua* (*Marconier*), *Waukesha* (*Meissonier*), *Middleburg* (*Grenadier*), *Lynchburg* (*Fusilier*), *Aurora* (*Carabinier*).

Light Vessel Launched

Light Vessel No. 103 was launched by the Consolidated Shipbuilding Corporation, at their Morris Heights yards, New York City, Saturday, May 1. Miss Beatrice A. Fromme, daughter of Harry Fromme, chief engineer of the Consolidated plant, christened the vessel. The ship is built of steel, 96 feet 5 inches in length, 24 feet beam, has a depth of 11 feet 9 inches, with a draft of 9 feet 6 inches. The propelling machinery consists of a double cylinder, 12 by 12, with 14-inch stroke engine, steam being supplied by a 9-foot 6-inch Scotch boiler.

The Light House Department, Washington, D. C., authorized the construction of this vessel, and her destination is the St. Claire River, Detroit, Mich.

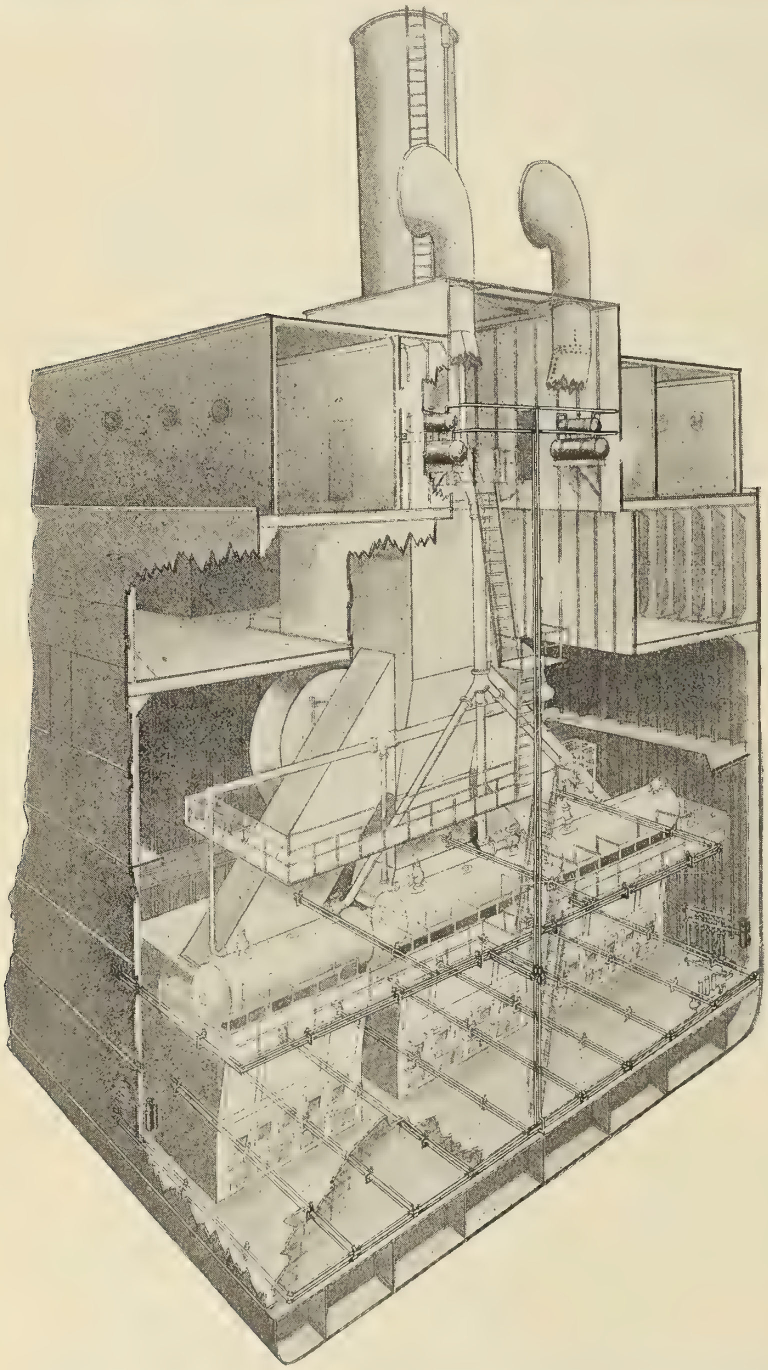
Protecting Boiler and Engine Rooms of Oil-Burning Vessels

The boiler and engine rooms in oil-burning vessels and motor vessels have represented one of the greatest fire hazards in the marine field. Until recently the only form of protection available in this part of the vessel was that afforded by hand extinguishers, which have been hardly adequate in taking care of the risk. Fire spreads so rapidly in the oil-soaked spaces that the crew is nearly always driven out of the hold. Extensive extinguishing systems which utilize steam or other gases in smothering the flame increase the danger to the crew.

Carbon dioxide puts out fire quicker than ordinary extinguishing agencies and prevents reignition. This gas has been utilized by the Foamite Firefoam Company, 200 Fifth avenue, New York, as part of a fire extinguishing system in which it is held in a tough foam blanket which smothers a blaze. The gas bubbles are retained in this foam until the burned surface cools, and there is no danger of the fire spreading.

It is claimed by the manufacturers of Foamite that it will not damage any part of the vessel; it is not injurious to the crew; does not affect steel, wood, fabric or any painted or varnished surface, and when dry only a fine powder remains, which is easily brushed away.

Boiler and engine rooms are usually saturated with the drippings from the burners, oil pumps and engines, the excess of which finds its way finally to the bilge. A break in the oil line, spraying the oil in all directions, or a back flash from the burners, may at any time spread a fire over the entire hold, driving out the crew and leaving no effective means of coping with it. For protection in such cases a sprinkler system by means of which the carbon dioxide foam blanket may be spread over the entire hold is installed. Two pressure tanks containing the proper solutions are connected by pipe lines to sprinkler heads in which the solution combine and are sprayed over the burning area. The controls for the system are located at any convenient point in the ship, and operate either automatically or manually, so that it is not necessary for the crew to remain in the fire region.



System for Spraying Carbon Dioxide Foam Blanket Over a Boiler Room

F. W. Sinram Honored

At the fourth annual convention of the American Gear Manufacturers' Association in Detroit, April 29, 30 and May 1, Mr. F. W. Sinram, president of the Van Dorn & Dutton Company, of Cleveland, was for the fourth time unanimously re-elected to the presidency of the association. It has been the policy of the association for the directors to elect all officers, and Mr. Sinram had requested that his name be not presented for the fourth term. In this instance the board elected the vice-president, secretary and treasurer, but left the naming of the next president to the association at large.

After the announcement of the three new officers, Mr. John B. Foote, president of the Foote Bros. Gear & Machine Company, Chicago, in behalf of the association, presented to Mr. Sinram a handsome gold watch and charm. Before the recipient had recovered from "shell shock" he had again been re-elected by acclamation.

The A. G. M. A. is the industry organization of the gear manufacturers, and includes in its membership practically every representative gear interest in the United States and Canada.

Morse Company Wins Bonus

Completing what is conceded to be a record ship bottom repair job, the Morse Dry Dock & Repair Company, of Brooklyn, N. Y., has earned from the Standard Oil Company of New Jersey, owners of the steamship *F. Q. Barstow*, upon which ship the work was done, a bonus of $1,000 per day for the three and one-half days within the contract.

The *Barstow* had been damaged as the result of being grounded after striking a submerged obstruction and being in collision with the steamer *Paddleford* off Tampico, in the Gulf of Mexico. The tenders for repairing the ship were submitted on April 8, and as time was an important factor the Morse Company was awarded the work, although its bid was about $11,000 in excess of the low bid.

Work on the ship started at 1 o'clock April 9. It involved the removal and

renewal of 85 plates, the repairing of frames and work throughout the tanks, the testing of the tanks, fairing and replacing in the way of hull damage. The ship was completed on Sunday afternoon, April 25. Some additional work was attended to on Monday and Tuesday, and on Tuesday evening, April 27, the work was completed.

The 30,000-ton floating drydock, and its close proximity to a highly organized plate and hull department, figured largely in the making of this record.

BUSINESS AND PERSONAL NOTES

The Foundation Company announces that it removed to its own building, No. 120 Liberty street, New York, on May 10.

H. W. Fielden, auditor, and C. F. Jemison, treasurer, of the Penn Seaboard Steel Corporation, 1417 Sansom street, Philadelphia, have been appointed comptroller and treasurer, respectively, of the Tacony Steel Company.

The Merchant Shipbuilding Corporation announces that on May 15, 1920, its general offices were moved from Finance building, South Penn Square, to Estey building, Seventeenth and Walnut streets, Philadelphia, Pa.

The Edward P. Farley Company announce the removal of their offices from 1501 Railway Exchange to the Tower building, 6 North Michigan avenue, Chicago.

Centrifugal pumps of the single- and multi-stage types for various services are described in an illustrated catalogue just issued by the De Laval Steam Turbine Company, Trenton, N. J. This company makes a practice of guaranteeing each pump fully as to the head, delivery and efficiency possible, as well as to the workmanship and materials, and each pump is tested before shipment. Manufacture is on an interchangeable basis.

Through an unfortunate oversight the name of the Ashton Valve Company, 137 Liberty street, New York, was omitted from the list of exhibitors at the Marine Exposition published in our May number. The company exhibited a full line of their pop safety and relief valves and pressure and vacuum gages.

The New Jersey Zinc Company, 160 Front street, New York, announces the appointment of Mr. Bushnell Bigelow as assistant general sales manager, and Mr. Walter I. Hess, manager of Eastern sales. Mr. Bigelow has held the position of manager of Eastern sales previously, and Mr. Hess has been assistant sales manager.

The United States Shipping Board, Emergency Fleet Corporation, has awarded a contract to the American Clay Machinery Company for sixteen electric capstans for use on drydocks being built for the Corporation.

C. S. Steen, chief engineer of the Tacony Steel Company, has been appointed chief engineer of the Penn Seaboard Steel Corporation. He will have supervision of all engineering and designing of the Penn Seaboard and Tacony plants. His new appointment gives him a much broader field in the New Castle, Chester, Tacony and New Haven works of the Penn Seaboard Steel Corporation.

H. McL. Harding, designing terminal engineer, Concourse building, 52 Vanderbilt avenue, New York, announces the removal of his offices from the above address to 5730 Grand Central Terminal, Forty-second street, New York, N. Y. Telephone, Vanderbilt 3038.

The Los Angeles Shipbuilding & Dry Dock Company has strengthened its organization by the addition of Commander James Reed, Construction Corps, U. S. Navy, to its executive staff. Commander Reed has resigned from the naval service and accepted the position of assistant general manager. He is a member of the American Society of Mechanical Engineers, and a graduate of the United States Naval Academy, Annapolis, Md., in the class of 1902. The officers and directors of the Los Angeles Shipbuilding & Dry Dock Company are now as follows: Officers, Fred L. Baker, president and treasurer; S. L. Naphtaly, vice-president and general manager; Dan Murphy, vice-president and assistant treasurer; Erle M. Leaf, secretary; James Reed, assistant general manager; F. G. Phillipps, comptroller; Francis P. Duncklee, assistant secretary; John Murray, works manager. Directors, J. F. Sartori, Erle M. Leaf, Dan Murphy, S. L. Naphtaly, Fred L. Baker.

The Black & Decker Company, of Towson Heights, Baltimore, have removed their Philadelphia branch office from the West End Trust building to more spacious quarters at 318 North Broad street. The new office has a show window and show room, as well as a completely equipped service station for the convenience of users of Black & Decker electric air compressors, portable electric drills and electric valve grinders. It is in charge of Mr. W. C. Allen, branch manager.

The Electro Sun Company, Inc., distributors of supplies and equipment for engineers, architects and draftsmen, announces the removal of its office from 27 Thames street to 161 Washington street, New York City. In connection with the expansion of this company a catalogue has been issued describing the materials and supplies available for engineers and draftsmen. The descriptions and specifications are complete, as the catalogue has been intended as a source of information in this particular field. The catalogue will be supplied by the company on request.

The Page Steel & Wire Company announce that since their consolidation with the American Chain Company their offices have been removed to suite 1054 Grand Central Terminal, New York City. Telephone, Vanderbilt 4050.

MARINE SOCIETIES

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

NATIONAL ASSOCIATION OF ENGINE AND BOAT MANUFACTURERS
29 West 39th Street, New York City.

UNITED STATES NAVAL INSTITUTE
Naval Academy, Annapolis, Md.

NATIONAL ASSOCIATION OF MASTERS, MATES AND PILOTS

National President—John H. Pruett, 428 Forty-ninth St., Brooklyn, N. Y.
National Treasurer—A. B. Devlin, 187 Randolph Ave., Jersey City, N. J.
National Secretary—M. D. Tenniswood, 808 Vine St., Camden, N. J.

LIST OF OFFICERS, AMERICAN SOCIETY OF MARINE DRAFTSMEN

President—A. H. Haag, 127 Woodside Ave., Narberth, Pa.
Vice-President—C. E. Deiser, 6124 Nassau Road, Philadelphia, Pa.
Secretary—B. G. Barnes, 6 Meadow Way, Bath, Maine.
Treasurer—J. B. Sadler, P. O. Box 987, Norfolk, Va.
Executive Committeemen—G. W. Nusbaum, Washington, D. C.; E. H. Monroe, Washington, D. C.; John Thomson, Bethlehem, Pa.

NATIONAL MARINE ENGINEERS' BENEFICIAL ASSOCIATION OFFICERS

National President—Wm. S. Brown, 356 Ellicott Square Bldg., Buffalo, N. Y.
National Secretary-Treasurer—Geo. A. Grubb, 356 Ellicott Square Bldg., Buffalo, N. Y.

CANADA

GRAND COUNCIL, N. A. OF M. E. OF CANADA

Grand President—E. Read, Rooms 10-12, Jones Building, Vancouver, B. C.
Grand Vice-President—Jeffrey Roe, Levis, P. Q.
Grand Secretary-Treasurer—Neil J. Morrison, Box 886, St. John, N. B.
Grand Conductor—E. A. House, Box 333, Midland, Ont.
Grand Door Keeper—Lemuel Winchester, 306 Fitzroy Street, Charlottstown, P. E. I.
Grand Auditor—W. C. Woods, Toronto, Can.
Grand Auditor—J. C. Adams, 1704 Kitchner Street, Vancouver, B. C.

GREAT BRITAIN

INSTITUTION OF NAVAL ARCHITECTS
5 Adelphi Terrace, London, W. C.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND
39 Elmbank Crescent, Glasgow.

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS
Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORPORATED
The Minories, Tower Hill, London.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIP CONTRACTS

Freighters, Ecorse, Mich.—The Great Lakes Engineering Works has prepared designs and plans for at least ten new freighters which will probably be built this summer.

Freighters, Manitowoc, Wis.—The Manitowoc Shipbuilding Company will build five 3,300 tons deadweight freighters for its own account, keels for which will be laid immediately.

Barkentines, Victoria, B. C.—Building of four wooden barkentines will be begun soon by the Victoria Ship Owners, Ltd., of Victoria, B. C. They will be 2,500 tons each, and will cost $250,000 each.

Tankers, Portland, Oregon.—The Northwest Steel Company, Portland, will build seven 12,000-ton tankers for the Swift Sure Oil Tank Transport Company. J. R. Bowles is president of the steel company.

Steamers, Pacific Coast.—Announcement is made that H. F. Alexander, president of the Pacific Steamship Company, is making inquiries regarding moderate sized steamers for operation on the Pacific Coast.

Steamers, China.—Orders for five steamers have been placed by the China Merchants Steam Navigation Company. Four will be built in Chinese yards and the other in a British yard. Details not yet available.

Tanker, Seattle.—The Skinner & Eddy Shipbuilding Company received a contract rfo two 13,500 ton oil tankers for Norwegian interests, requiring ten months to build. A 3,600 horsepower engine will be installed.

Passenger Steamers.—The New York & Porto Rico Steamship Company has had two 400-foot steamers designed by Theodore Ferris for passenger and freight service, and it is expected that bids will be asked for very soon.

Barkentines, Seattle, Wash.—The Frank W. Haviside Company, of Seattle, Wash., has purchased two of the big Ferris-type hulls built at Eureka, Calif., from the Shipping Board, and will complete them as five-masted barkentines.

Tankers, Pascagoula, Miss.—Negotiations are in progress for the building of six tankers at the National Shipbuilding Company's plant. The steamers wlli be of 3,800 to 4,000 net tons, and used in the Texas-Mexico oil trade.

Tankers, Sparrow's Point.—It is reported that two bulk oil carriers, of about 10,000 tons each, have been ordered by French interests from the Bethlehem Shipbuilding Corporation, Ltd. They will probably be built at the Sparrow's Point plant.

Cargo Steamers, Glasgow, Scotland.—The Cork Steamship Company, Ltd., have placed an order with Ferguson Brothers, Port Glasgow, for three steamers for the continental cargo trade. Swan, Hunter & Wigham Richardson, Ltd., are building four vessels for the same company.

Freighters, Norwegian-American Line.—Four new freighters for the Norwegian-American Line are being built by Napier & Miller at Glasgow, Scotland. Two are of 9,500 tons, and two of 7,500 tons. The Canadian Vickers, at Montreal, are building two 6,500-ton steamers for the same line.

Ice Breaker, St. Lawrence River.—The Canadian Department of Marine, Ottawa, Canada, has authorized the construction of an ice breaker for use on the St. Lawrence river. The vessel is to have 8,000 horsepower, will carry a crew of 90 men, and the estimated cost is $2,000,000.

Tankers, Orange, Texas.—The National Shipbuilding Company, of Orange, Texas, has purchased five of the Ferris-type ships at the plant of the Beaumont Shipbuilding & Dry Dock Company, Beaumont, Texas, will have them planked with creosote sheathing, and install tanks for their use in the oil trade.

Tankers, Everett, Wash.—The Norway Pacific Shipbuilding Company has received contracts for seven oil tankers and six oil storage basins to cost approximately $20,000,000. Five tankers will be of 10,000, and the other two 3,500 tons each. The storage basins will have a capacity of 300,000 barrels.

Steel Barges, Newark, N. J.—The Submarine Boat Corporation, has inaugurated construction of small cargo carrying all steel barges. The first fleet to be built will be used for canal service between Buffalo and New York. They will be built similar to the large fabricated steel vessels built for the Government.

Fruit Steamer, Newburgh, N. Y.—The keel for another ship for the Cuyamel Fruit Company has been laid at the Newburgh, N. Y., Shipyards. The vessel will be 301 feet 6 inches between perpendiculars, molded beam 42 feet, molded depth 25 feet, with twin screw reciprocating engines and three Scotch boilers, giving a speed of 14½ knots.

Tanker, Chester, Pa.—The Norwegian-American Line has placed an order with the Sun Shipbuilding Company Chester, Pa., for a 10,600-ton tanker, 430 feet long, 59 feet beam, 33 feet 3 inches deep, triple expansion engines, Scotch boilers, and with a speed of 10½ knots on a consumption of 30 tons of fuel oil daily. She will be built on the Isherwood system.

Passenger Liner, Camden, N. J.—The Munson Steamship Line, 82 Beaver street, New York, has placed a contract with the New York Shipbuilding Company, Camden, N. J., for a 15½-knot passenger liner of 6,000 tons gross register, oil burning, with steam turbine engines, and fitted especially for tropical service. The cost will be between $2,500,000 and $3,000,000.

Tanker, Camden, N. J.—The Sun Shipbuilding Company has received a contract from French interests for a 6,600-deadweight tank steamer. The name of the company ordering the steamer has not been made public. The Sun Company recently launched a steamer which was the first contract taken by an American yard from a foreign country after the armistice was signed.

Tankers and Barges, Bath, Maine.—The Texas Company has placed an order with the Texas Steamship Company for two 9,500-ton steel tank steamers, duplicating other vessels built at the company's yard, except that Scotch boilers will be installed; also for three steel harbor barges each with a capacity of 7,500 barrels of heavy Mexican oil. These barges are to be fitted with Scotch boilers to supply steam for operating cargo pumps, heaters, etc. The Carnegie Steel Company has the contract for the material involved.

Ore Steamer, Fore River.—The steamer Cubore, building at the Fore River plant of the Bethlehem Shipbuilding Corporation, Ltd., to be used in bringing ore from Cuba, will be of 11,400 tons deaweight, is 468 feet over all, 57 feet beam, 27 feet draft. She will be equipped with a 2,500-horsepower Diesel engine, and will have a speed of 10 knots loaded. In addition to the usual ballast tanks she will have side tanks, making practically a double hull, and six big hatches, allowing her to load in five and a half hours.

Passenger Vessels, Glasgow, Scotland.—In connection with the program for the extension of the fleet of the Nippon Yusen Kaisha (Japan Mail Steamship Company), Tokyo, William Denny & Bros., Ltd., of Dumbarton, have received from that company orders for two vessels, each 395 feet long and about 5,000 gross tons. These vessels are for fast passenger service, with a speed of 18½ knots. They will be built under the supervision of A. R. Brown, MacFarlane & Company, Ltd., the company's Glasgow agents.

Tanker, Staten Island, N. Y.—The Staten Island Shipbuilding Company will build for the American Sugar Refining Company, of New Jersey, a 6,300 deadweight ton steel combination bulk molasses and oil tanker; estimated cost $1,500.000. Dimensions: Length, 360 feet; molded breadth 50 feet, and molded depth, 29 feet. The vessel will be of steel, single-screw type, with straight stem and elliptical stern, built on the longitudinal system of framing, with two steel decks, raised poop, forecastle, bridge, with bridge house over house on poop deck. The machinery will be located aft. The pump room will be forward of the boiler room. There will be a double bottom under the machinery space with compartments for carrying feed water. The ship will be able to carry cargo in some of its compartments. The hold will be divided into six tanks, for oil or molasses in bulk, with a fuel tank between cargo tanks Nos. 3 and 4.

SHIPYARDS AND DRYDOCKS

Drydock, New Orleans, La.—The Jahncke Dry Dock & Ship Repair Company, New Orleans, will equip a third drydock with a lifting capacity of 6,000 tons.

Drydock, Seaford, Del.—The Delaware River Shipbuilding & Repair Company has placed a contract with the Crandall Engineering Company, of Boston, for the construction of a 3,000-ton dry dock at its Seaford, Del., yard.

Shop, Fairfield, Md.—A permit for the construction of a one-story shop, 60 by 400 feet to cost $67,000 has been granted to the Globe Shipbuilding & Dry Docks Company, which is building a plant at Fairfield, Baltimore.

Steel Shop, Quincy, Mass.—The Bethlehem Shipbuilding Corporation Ltd., has awarded a contract to Snare & Triest, 8 West 40th street, New York, for a three-story concrete steel shop addition to its Fore River (Mass.) plant, to cost about $75,000.

Schooner, East Boothbay, Maine.—At the Adams yard a schooner of 105 feet keel, to be used for trading purposes between San Francisco and the South Sea Islands, will be ready for launching in June, and will be equipped with a Standard 45 H. P. engine.

Cargo Carrier Launched, Bath, Maine.—The Texas Steamship Company on May 1 launched the 10,000-ton cargo carrier Occidental at its Bath, Me., yard. The company has two more 10,000-ton ships on the ways, and more vessels to build as fast as the ways are vacated.

Marine Railway, Portland, Ore.—Supple & Martin are planning a marine railway for their shipbuilding plant at Linnton. The railway is to be provided with laterals, which will bring ships to be shunted to the machine shops and sawmill. The new device is expected to lift a vessel out of the water in thirty minutes.

Shipyard Sold, Portland, Oregon.—The Northwest Steel Company, Portland, ha sold its shipbuilding plant to the Northwest Bridge & Iron Company, a new organization. Contracts recently awarded to the Northwest Steel Company for seven 12,000-ton steel tankers by the United States Shipping Board were also taken over.

Marine Railway, Boothbay Harbor, Maine.—The Atlantic Coast Company, owned principally by Crowell & Thurlow, of Boston, is soon to begin building a marine railway capable of hauling out vessels of more than 2,000 tons, at its Boothbay Harbor yard. At present there are two 1,200 four-masted schooners at the yard, which will be launched this fall.

New Yard, Sturgeon Bay, Wis.—Joseph Wolters, who sold his shipyards at Sturgeon Bay to the Universal Shipbuilding Company two years ago, plans to build a new yard which will have one of the largest floating drydocks on the lakes. Prominent men in the shipping interests of that section of the lakes are financially interested in the project.

Tankers, Port Jefferson, L. I., N. Y.—The Bayles Shipyard at Port Jefferson, Long Island, which has been taken over by the New York Harbor Dry Dock Company, has launched the tanker Anahuac She is of 1,200 tons displacement, 180 feet long, 31 feet beam, 16 feet depth, with a capacity of 7,000 barrels, and was built for the Nyack Shipbuilding Company. A 3,500-ton ship will be launched on June 2.

New Shipyard, Algiers, Africa.—A company is forming at Algiers for the purpose of erecting a shipbuilding plant. According to reports three slips will be constructed at Fort de L'Eau, in the center of the Bay of Algiers, and it is hoped during the first year of the company's existence to complete the hulls of three vessels of 3,000 to 3,500 tons each. It is proposed to build the hulls only in Algeria.

Manila Dock Merger, H. I.—The Honolulu Iron Works, a Hawaiian firm, and Earnshaw's Slipways & Engineering Company, a Philippines concern, have been merged into a corportion known as Earnshaw's Dock & Honolulu Iron Works, which among other things, will operate a large dry dock and ship repairing establishment. At present about 2,000 men are employed in ship docking and repairing.

Fruit Steamer, Staten Island, N. Y.—The Standard Shipbuilding Corporation launched the first of two fruit steamers built for the Cuyamel Fruit Company, of New Orleans, on Saturday, May 8. The vessel is named the Hibueras, and is a special type combination passenger and cargo steamer, 235 feet long, 34 feet beam, 16 feet deep. The company is also constructing four 8,800-ton of the "gold shell" type, for the Eagle Oil Transportation Company, of London, England.

Freight Terminal, Greenville, N. J.—The Lehigh Valley Railroad plans three piers, to be known as the Claremont piers, at its terminal in Greenville. The first half of one of the piers about to be built will be 3,000 feet long, and each of the three piers when built will be 7,000 feet long. They will provide six miles of dock space with open and warehouse storage facilities and all modern features. The piers will be 400, 350 and 300 feet wide, with slips 500 feet wide at the pier heads, tapering to a maximum inshore width of 450 feet. The first unit will replace the Lehigh Valley's ore dock at Constable Hook, and the whole operation will require 12,000,000 cubic yards of dredging.

PORT IMPROVEMENTS

Bulkheads, Miami, Fla.—The Alton Beach Realty Company plans to construct 2½ and 2-mile bulkheads at Miami, Fla.

Pier, Marcus Hook, Philadelphia.—The Sun Oil Company plans to build a pier at its property at Marcus Hook. It will be a solid structure, 520 feet long and 200 feet wide.

Wharf, West Norfolk, Va.—S. G. Williams & Company has been awarded contract to build a wharf for Hastings Brothers, stevedores, at West Norfolk, Va., estimated cost $25,000.

Sea Wall, Boston, Mass.—City has let contract for building 1,350 foot concrete sea wall and back fill at Albany street, to N. S. Rendle, 364 Border street, East Boston, Mass. $200,823.

Piers, New York.—Bids will be received until June 2 by Murray Hulbert, Commissioner of Docks, Pier A, North River, for building piers at Stanton street, East River. About $200,000.

Dredging and Repairing Pier, New York.—The city has begun the work of dredging and repairing at Pier 72, at East 24th street, to cost about $90,000. When the work is completed the pier will be leased to the highest bidder.

Pier, New York City.—Murray Hulbert, Commissioner of Docks, Pier A, North river, has let contract for lumber pier and freight shed at 5th street, East river, to Associated Contractors Corporation, 17 West 42nd street. $122,790.

Pier, Jersey City, N. J.—Henry Steers, Inc., 17 Battery Place, New York City, has been awarded contract to build a pier and channel warehouse at Jersey City for the Claremont Terminal, Lehigh Valley Railroad, of 143 Liberty street, New York City.

Breakwater, Toronto Island, Ontario, Canada.—The Department of Public Works has let contract for building rubble mound breakwater on brushwood fascine mattress in Lake Ontario to R. McDonald Company, Ltd., Crown Office building, Toronto. $201,840.

Wharf, Astoria, Oregon.—G. W. Sanborn Company let contract for building 500 foot wharf, 125 foot railway extension from railroad to pier head line, two 50x110 feet slips, 40x75 feet pier and warehouse to Hilpin Construction Company, Astoria. About $70,000.

Steamer Dock, Vancouver, Wash. — City having plans prepared for building first unit of new steamer dock, 964 feet frontage, concrete and steel with frame wood piling, including 100x500 foot warehouse. About $130,000. A. C. Shumway, Vancouver, engineer.

Terminal, Providence, R. I.—The Zenith Transportation Company has leased the north side of the State pier on Allen's avenue, Providence, and will make it a terminal for cargo steamers to and from the Atlantic Coast and European points. The company is a subsidiary of M. F. Donovan & Sons, 100 Broadway, New York.

Quay Reconstruction, The Clyde, England.—The trustees of the Clyde Navigation, Glasgow, Scotland, have awarded to Sir William Arrol & Company, Ltd., a contract for extending 375 lineal feet of quayage at the net cost of materials and wages plus £20,000 for all charges, use of plant, and commissions; total estimated cost £94,000.

Marine Railway, Portland, Oregon.—The construction of a marine railway to cost about $250,000, which will accommodate vessels 300 feet in length, has been determined upon by Supple & Martin, operating the former plant of the Columbia Engineering Works at Linnton. No definite plans have been decided as to when construction will begin.

Bulkhead Wharf, San Francisco, Calif.—State Board Harbor Commission, Ferry building, let contract for building wood pile and cement bulkhead wharf in front of pier 27, connecting existing bulkhead wharves at piers 25 and 29 and constructing pile wharf connecting piers 25 and 27 to Healy, Tibbits Construction Company, 9 Main street; $38,717. State furnishes creosoted piles and cement.

Port Improvements, Philippine Islands.—Consideration of the establishment of a free zone in Manila and the decision to issue $6,000,000 of Government bonds for port works improvement are important steps taken by the Philippine Legislature. Among contemplated improvements to Manila harbor are the construction of additional piers, the tunneling of the Pasig river, the construction of coal and oil depots, and the dredging of the harbor to a depth of forty feet.

Terminal Facilities, New York City.—Bills have been signed by Governor Smith, of New York, authorizing the City of New York to construct terminals and warehouses, and providing for the straightening of the Harlem Ship Canal. Murray Hulbert, Dock Commissioner, says that probably $35,000,000 will be spent within the next two years as an initial outlay, of which $25,000,000 will go toward the terminal and warehouse establishment at Stapleton, S. I., and $9,500,000 for the Harlem river improvement project.

GOVERNMENT WORK

Dredging, Cleveland, Ohio.—United States Engineer Office, Federal building, has let contract for dredging and removing wharf in Huron Harbor to Great Lakes Dredge & Dock company for $24,191.

Crane Runway, Washington, D. C.—Specification 4174. Bureau of Yards and Docks, Navy Department, receives bids for building on existing foundations about 213 tons structural steel to form extension to Gun Park crane runway at Navy Yard. About $4,400.

Preparing Plans.—Plans are being prepared and bids will be called for by U. S. Engineers' office, Washington, D. C., when ready, for constructing new pier and dredging Newport; specification 4090; alteration to marine railway, Rockaway, L. I., specification 4184.

Steel Catamarans for Porto Rico.—The United States Engineer's Office, War Department, Washington, D. C., let contract for steel catamarans for dredging in San Juan harbor, Porto Rico, to Greenlie, Halliday & Company, 499 Water street, New York. About $46,000.

Tracks, Naval Drydock, South Boston, Mass.—Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids for completing track system around drydock for special heavy drydock crane, and standard railroad equipment, etc.; specification 4196; about $120,000; $10 deposit for plans, etc.

Navy Yard Improvements, Philadelphia, Pa.—The Navy Department, Washington, D. C., is arranging for additions and improvements at the League Island Navy Yard during the coming year. The estimated expenditures are placed at $17,268,360, and this amount has been incorporated in the naval bill is now written; $11,000,000 will be used for construction and repair work, $2,500,000 for steam engineering service, $780,000 for ordnance and $1,000,000 for supplies.

Dredging, Saybrook, Conn.—United States Engineering Office, Providence, R. I., will receive bids until June 7, for maintenance dredging on Saybrook Bar, at the mouth of the Connecticut river.

Dredging, Malden River, Mass.—The United States Engineer's Office, Custom House, Boston, will receive bids until June 10 for dredging in Malden River, Mass. Information on application.

Dredging, New Jersey.—United States Engineering Office, 39 Whitehall street, will have specifications made for maintenance dredging in Keyport harbor, Shrewsbury river and other places in New Jersey.

Dredging Channel, Gulfport, Miss.—Work on the Gulfport channel has been started according to Major R. S. Thomas, United States engineer, and shoal places between the pier and Beacon 19 will be cleaned out.

Rebuilding Quay Walls, Scotland.—Among a number of schemes of harbor improvements which the Clyde Trustees have on hand at present is the reconstruction of the quay walls which collapsed at two parts of the harbor. It has been agreed to construct the quay wall 10 feet further into the river.

SHIPPING DEVELOPMENTS

Steamship Service, Mobile, Ala.—The Isthmian Line service from Mobile was inaugurated by the sailing of the steamer Chickasaw City, of the United States Steel Corporation, on May 14.

The New England Maritime Corporation, of Boston, has changed its name to North Atlantic & Western Steamship Company, providing monthly freight service between Boston and Pacific Coast ports.

Steamship Line Sold, Montreal, Canada.—Canada Steamship Lines, Ltd., has sold the Quebec Steamship Company lines operating between New York and the West Indies, to Furness, Withy & Company, Ltd.

Steamship for Coal Trade, Charleston, S. C.—The fleet of vessels operated by the Clinchfield interests in the coal trade between Charleston and Cuba has been increased by the addition of the steamer Cotopaxi.

Barge Line, Troy, N. Y.—The barge Edna Schum was launched at Kingston for the Lighters' Transportation Company, of New York, which inaugurated a barge line between Troy, Albany and New York.

New Shipping Company, London, England.—The Urbs Shipping Company has been organized with a capital of £50,000 to carry on the business of shipowners, etc. Solicitor, M. W. Starling, 5-6 Great Winchester street, E. C.

Reconditioning Steamer.—The passenger steamer Powhatan, 10,831 tons, chartered by the Shipping Board to the International Bureau of Supplies, is to be reconditioned by the charterers at a cost estimated at $2,350,000.

Restricting Loans, England.—British bankers are restricting loans on new shipping enterprises. One Cardiff concern, which had relied on a 50 percent loan on a newly bought steamer, was informed by the bank that it would lend only 30 percent.

Belgium Buys Steamers.—Two more American built steamers, the Fire Island and Long Island, both of Philadelphia, have been sold and placed under the Belgian flag. The Fire Island has had its name changed to Ionie and the Long Island to Argentinier.

Buy Steamers, New York.—The Elder Steel Steamship Company, 50 Broad street, New York, paid the United States Shipping Board in full for two steamers, the West Catanace and the Deerfield, the latter a refrigerator. The total cost of both vessels was $4,500,000.

New Steamship Company, New York.—The Five-Continent Steamship Company, 2 and 4 Stone street, proposes to operate ships in a number of trades soon. Robert S. Wild is vice-president and general manager, Lief S. Erickson chartering manager, and J. B. Magill traffic manager.

Pleasure Steamer, Great Lakes.—The Canada Steamship Lines are building a pleasure steamer for the Great Lakes service which will be fireproof and have a speed of 18 knots. It is planned to carry moving picture theatres, a children's playground, dancing pavilion, terraced decks, and other novel features.

Buys More Ships, Baltimore, Md.—The Standard Steamship Company, of 26 Cortlandt street, and Baltimore, is buying additional tonnage from the Shipping Board. The company's president is Guert G. Jackson; vice-president, J. F. Hefferman; treasurer, J. D. Childs, and secretary, J. B. Murray.

Harbor Tugs Bought, Norfolk, Va.—Two new river tugs, the Fannabelle Stewart and the Alexander Stewart, of 10 and 20 tons respectively, have been purchased by the Stone Towing Company, Wilmington, N. C. This makes a fleet of nine boats operated by the company at this port and Wilmington, N. C.

New York-Oriental Service, New York.—The Dollar Steamship Line inaugurated a new service between New York and the Orient with the sailing of the Grace Dollar of 6,000 tons capacity, the first of the fleet of freighters assigned to the route. The New York offices of the company are at 44 Whitehall street.

Transportation Line, Greenport, L. I.—Business men and others of Greenport, Sag Harbor, and other Long Island ports, are planning a transportation service between the east end of Long Island and New York. It is announced that they will form a company with $100,000 capital for that purpose, if they cannot make other arrangements.

Atlantic-Pacific Coast Service, Boston.—The first steamship, the Artigas, of the new line between Boston and Philadelphia on the East Coast, and San Pedro, San Francisco, Portland and Seattle on the west sailed from Philadelphia May 15. Another ship is booked for June 15. On their return voyages the vessels will call at San Juan, Porto Rico.

Portugal-Japan Line, Portugal.—The ex-German steamers Bulow, Prinz Henrich, Mark and Koenig Albert have been placed by the Portuguese Government at the disposal of the new service between Portugal and Japan. Two other liners and six cargo vessels will also be placed on this service which will be fortnightly.

New Shipping Company, Cardiff, Wales.—The Dawson Line, Ltd., has been registered with a capital of £200,000 to carry on the business of ship and tug owners, shipbrokers, shipping agents, carriers by land and water, etc. Directors are D. S. Dawson, J. M. Collings, W. J. Powell, T. Howe, and F. Dawson, 64 Merchants Exchange.

New Shipping Company, Newcastle-on-Tyne, England.—The Joplin & Hull Shipping Company, Ltd., has been organized with a capital of £100,000 to carry on the business of shipowners, managers of shipping property, etc. Directors, F. W. C. Common, L. A. Common, W. Joplin, C. E. Hull, B. E. Common, 15 Queen street, Newcastle-on-Tyne.

Late Delivery, Scotland.—The Peninsular & Oriental liner Naldera, which was under construction at the Greenock Works of Caird & Company when the war began, has just been delivered. She has been successively a cargo carrier, auxiliary cruiser and seaplane carrier, and is now a liner. Her changes have increased her ultimate cost to £2,000,000.

New Line, Port Newark, N. J.—The Transmarine Corporation, a subsidiary of the Submarine Boat Corporation, starts its first steamer, the Italia, to Havana on June 1. Other ships built at the Submarine's yards will follow. All the cargo the steamer can carry was supplied as soon as the announcement was made. Space was limited on account of channel conditions.

South American Service, Seattle, Wash.—The Pacific-Argentine-Brazil Steamship Line has begun a freight service from Seattle, Wash., down the North and South American coast, steamers returning to Seattle by way of Punta Arenas and the east coast of South America through the Panama Canal, touching at the principal ports. The first steamer in the service was the Pallas.

Standard Oil Shipping Committee.—As a result of the growth of its fleet of oil tankers and the increase in that branch of the company's business, a special shipping committee has been formed by the Standard Oil Company, of New Jersey, to exercise supervision over construction, repairing, maintenance and operation. D. T. Warden, manager of the marine department, is chairman.

Liner to be sold, England.—The British Admiralty has put up for auction the old passenger liner Teutonic, which is probably destined for the scrap heap. Up to 1910 she was in the Southampton-New York run and then went to Montral up to the beginning of the war. The British Admiralty bought her from the White Star shortly after the opening of hostilities, transforming her into an auxiliary cruiser.

Steel Company & Ship Lines Merger, Montreal, Canada.—The Dominion Steel Corporation, the Nova Scotia Steel & Coal Company, Canada Steamship Lines, Ltd., and numerous smaller companies have merged into one large company which has secured a charter under the name of British Empire Steel Corporation, Ltd., with an authorized capital of $500,000,000, which it is expected will be doubled.

New Steamship Line, Seattle, Wash.—The General Steamship Corporation, of San Francisco, has been named the agents for the Java-Pacific Line, which will establish a sea service between Seattle and Java on the arrival at Seattle of the 10,000-ton steamship Bondowoso. The General Steamship Corporation recently received the berth from the Shipping Board from San Francisco and other coast ports for Australia and New Zealand.

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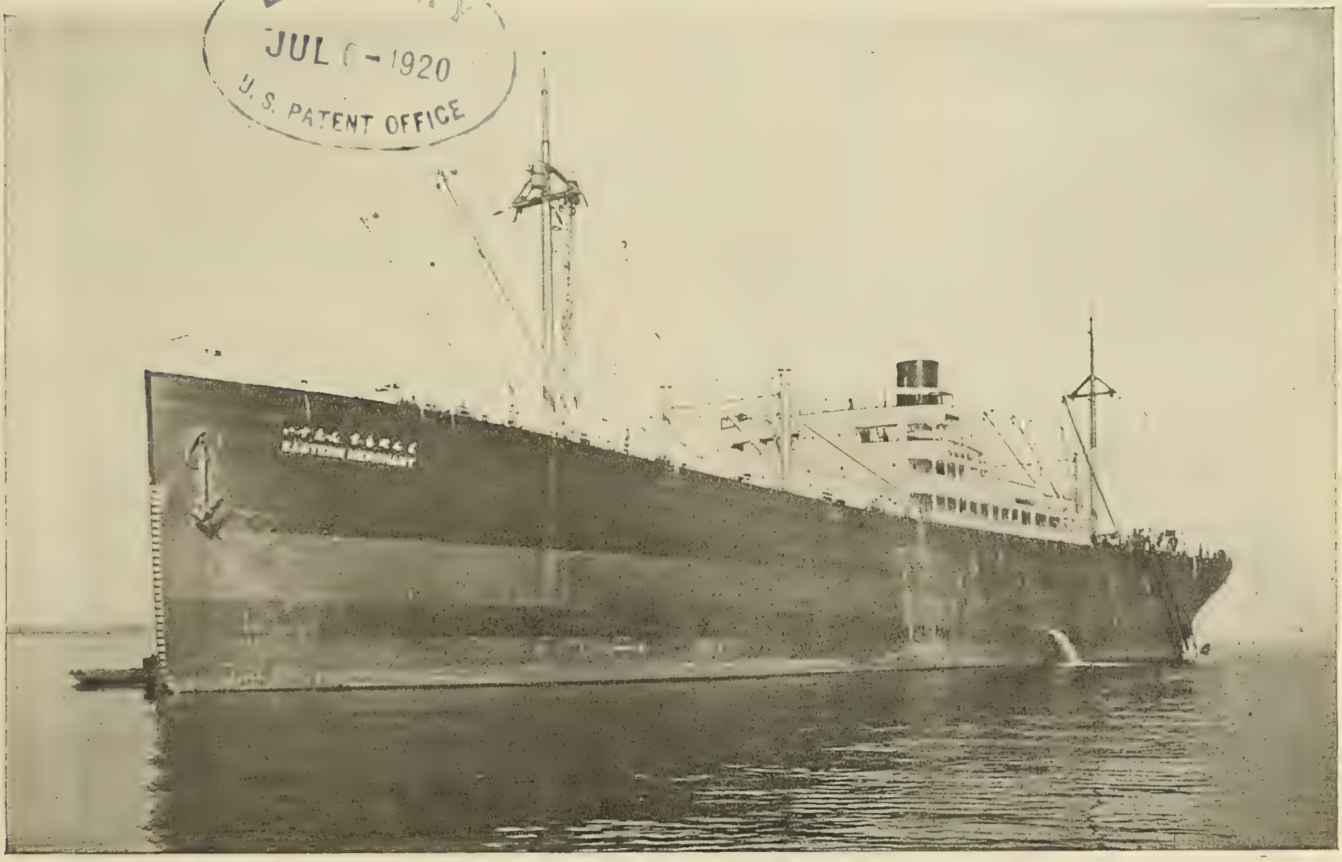


Fig. 1.— S. S. *Eastern Merchant* Nearly Completed

Twin Screw Cargo Ship Eastern Merchant

13,000-Ton Deadweight Freighter Built by the Asano Shipyard, Tsurumi, near Yokohama, Japan, for the United States Shipping Board

BY C. ANO*

DURING the late war, Japanese shipbuilders suffering from a lack of steel materials negotiated with the United States Government to build cargo steamers for them and to get steel in return. As a result of these negotiations two series of contracts were arranged between the United States Shipping Board and representatives of the Japanese shipbuilders.

The first series of contracts, which were signed during April, 1918, provided for the sale of twelve steamers of 100,800 tons deadweight by the Japanese shipbuilders at the rate of $225 to $275 per deadweight ton and for the release for export of 100,800 tons of steel already ordered by the Japanese shipbuilders from the various steel mills in the United States. The shipbuilders concerned in these contracts were the Asano Shipbuilding Company, Kawasaki Shipbuilding Company, Osaka Iron Works, Suzuki Company and Uraga Dock Company. Most of the ships under these contracts were, at the time of signing the contracts, ready for sea or in an advanced state of building, and contributed great assistance to the Allies in carrying war materials across the Atlantic. Later on three steamers having a total deadweight capacity of 27,000 tons were added to this series of contracts by the Kawasaki Shipbuilding Company.

The second series of contracts were signed in May, 1918, and their principal terms provided that the Japanese shipbuilders were to build and supply the ships to the United States Government at the rate of $175 per deadweight ton and that the United States Government was to supply the builders with half as many tons of steel material as the deadweight tonnage of the ships they supplied.

* Director and chief draftsman, Asano Shipbuilding Company.

Following is the complete list of the shipbuilders and number and tonnage of the ships they are building under these contracts:

Builders	Number of Ships	Deadweight Tonnage of Each Ship	Total Deadweight Tonnage
Asahi Shipbuilding Company........	1	5,500	5,500
Asano Shipbuilding Company.......	2	13,000	26,000
Fujinagata Shipyard................	1	6,300	6,300
Ishikajima Shipbuilding and Engineering Works	2	5,000	10,000
Kawasaki Shipbuilding Company....	5	9,000	45,000
Mitsubishi Shipbuilding Company...	2	8,400	16,800
Mitsui Company (Uno Shipyard)...	2	9,100	18,200
Nitta Steamship Company..........	1	5,500	5,500
Osaka Iron Works..................	4	10,500	42,000
Suzuki Company (Harima yard).....	1	5,000	15,500
Suzuki Company (Harima yard)....	1	10,500	
Uchida Shipbuilding Company......	2	8,500	17,000
Uraga Dock Company..............	3	6,650	19,950
Yokohama Dock Company..........	3	6,300	18,900

In spite of the great effort of the United States Government in arranging for quick delivery from the steel mills, none of the keels of the ships could be laid before the armistice. Among those ships the two Asano steamers are considered fine specimens of Japanese naval architecture, being the largest and only twin screw vessels built in Japan for the United States Government. The description of the first ship, *Eastern Merchant*, given herein will be sufficient to give a general idea of both ships.

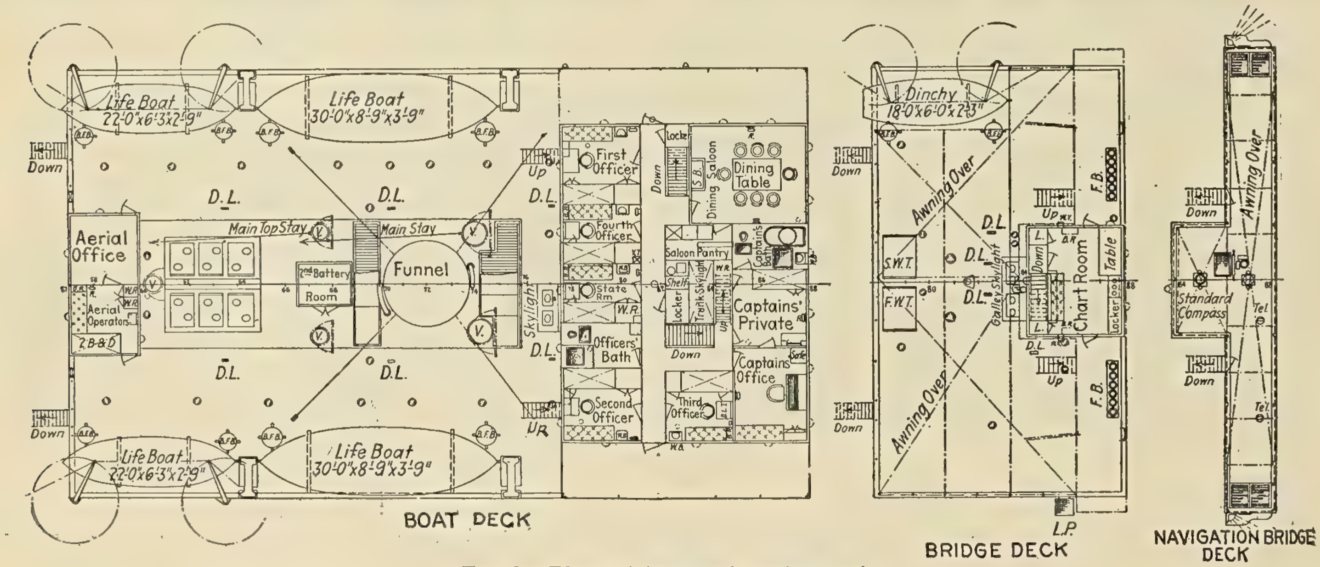


Fig. 2.—Plans of Boat and Bridge Decks

PRINCIPAL DIMENSIONS

The principal particulars of the *Eastern Merchant* are as follows:

Length overall	461 feet 7 inches
Length between perpendiculars	445 feet 0 inches
Breadth, molded	58 feet 0 inches
Depth, molded to shelter deck	40 feet 1 inch
Load draft	30 feet 4 inches
Gross tonnage	8,194 tons
Net tonnage	4,988 tons
Deadweight capacity	13,000 tons
Capacity for bale cargo at 40 cubic feet	14,000 tons

GENERAL ARRANGEMENT

The general arrangement is shown in the accompanying plans, from which it will be seen that the steamer is of the shelter deck type with three continuous decks, which are of steel throughout. Above the shelter deck there are steel deck houses to accommodate the officers and crew, the top of the midship house being extended to form a boat deck. There are seven steel watertight bulkheads, four of which extend to the shelter deck, and the others to the upper deck. A cellular double bottom extends the full length of the ship between the peak bulkheads, all of which will be used for the stowage of fuel oil, except the part under the engines, in which reserve feed water will be carried. The fore and aft peak tanks are also arranged for fuel oil. The total capacity of the fuel oil tanks, including the large settling tanks, is 1,768 tons, which will give the ship a steaming radius of about 11,000 miles.

FRAMING

The vessel is framed transversely, the frame spacing being generally 36 inches, reduced to 27 inches in No. 1 hold and to 24 inches in the peaks. Plate floors in the double bottoms are arranged on alternate frames, the intermediate floors being of bulb angle section, supported by flanged bracket plates. Widely spaced pillars of tubular section are arranged in the holds and tween decks, thus providing clear spacious holds for the storage of cargo. No side stringers are fitted except in the forward portion.

ACCOMMODATIONS

Accommodation for the officers and engineers is as shown on the illustration. The house on the boat deck is allotted exclusively for deck officers, the port side of the midship house for engineers, the starboard side for the steward and petty officers, and the after deck house for the exclusive use of the seamen and firemen, each quarter having a spacious and well equipped mess room. The saloon, captain's and chief engineer's cabins have been given special attention, the rooms being very tastefully finished in Japanese oak and pine. All officers' and crew's rooms are spacious, well ventilated and lighted and have been arranged to suit the special requirements of the American owners.

CARGO HANDLING ARRANGEMENTS

The loading and discharging arrangements are of a very efficient character. Eighteen wooden derricks and one heavy steel derrick are provided to load and discharge cargo through six large hatchways, with the aid of 7-inch by 12-inch double geared horizontal steam winches. As will be seen in the accompanying plan, the two steam winches forward of No. 2 hatch are arranged for heavy lifts to work on a large lifting drum placed on the ship's centerline, through forged steel clutches, and with the topping arrangement leading to a similar drum connected to the No. 1 winches. This arrangement enables a quick and safe working of cargoes of large weights.

TWIN SCREW CARGO SHIP EASTERN MERCHANT

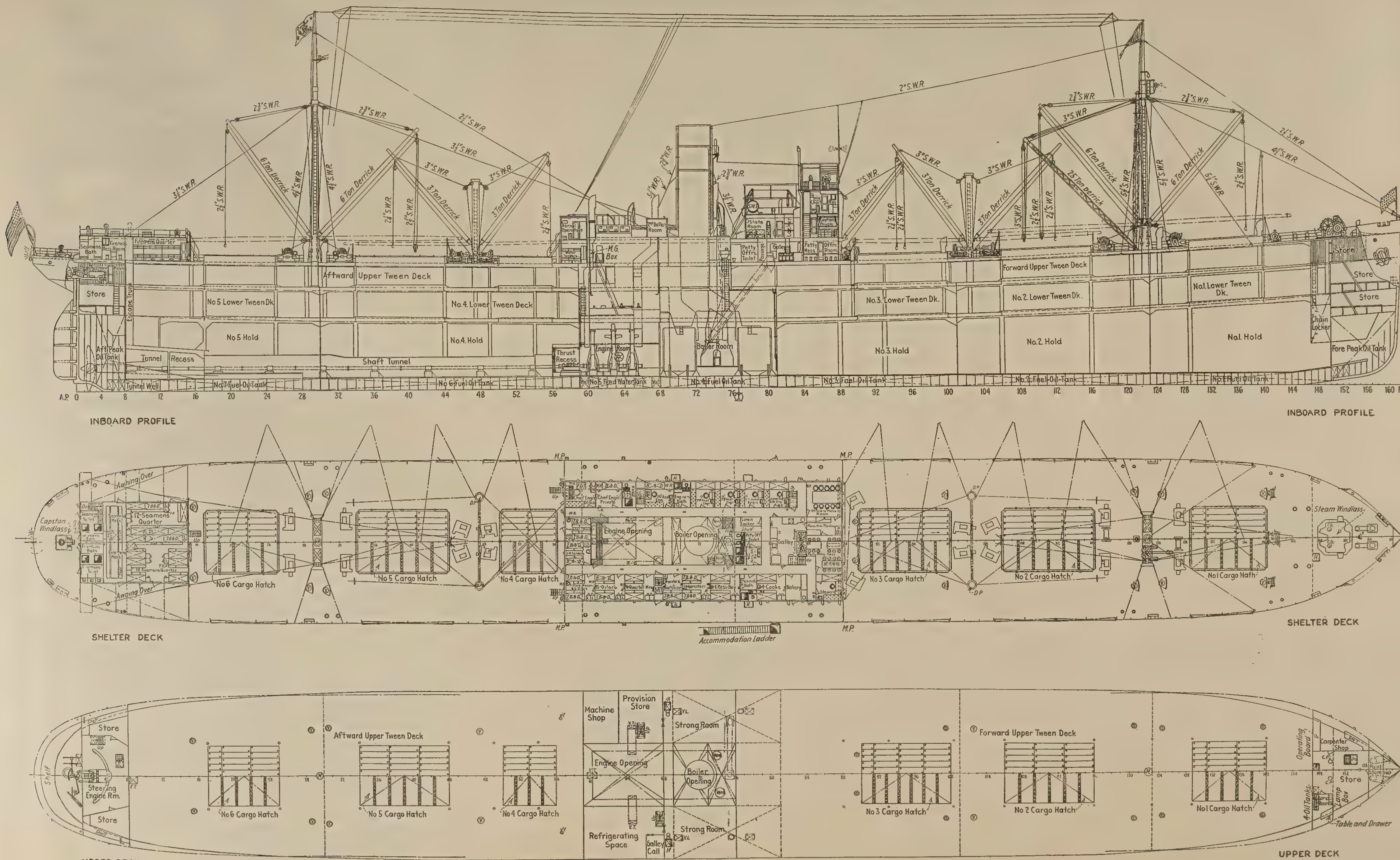


Fig. 3.—Profile and Deck Plans

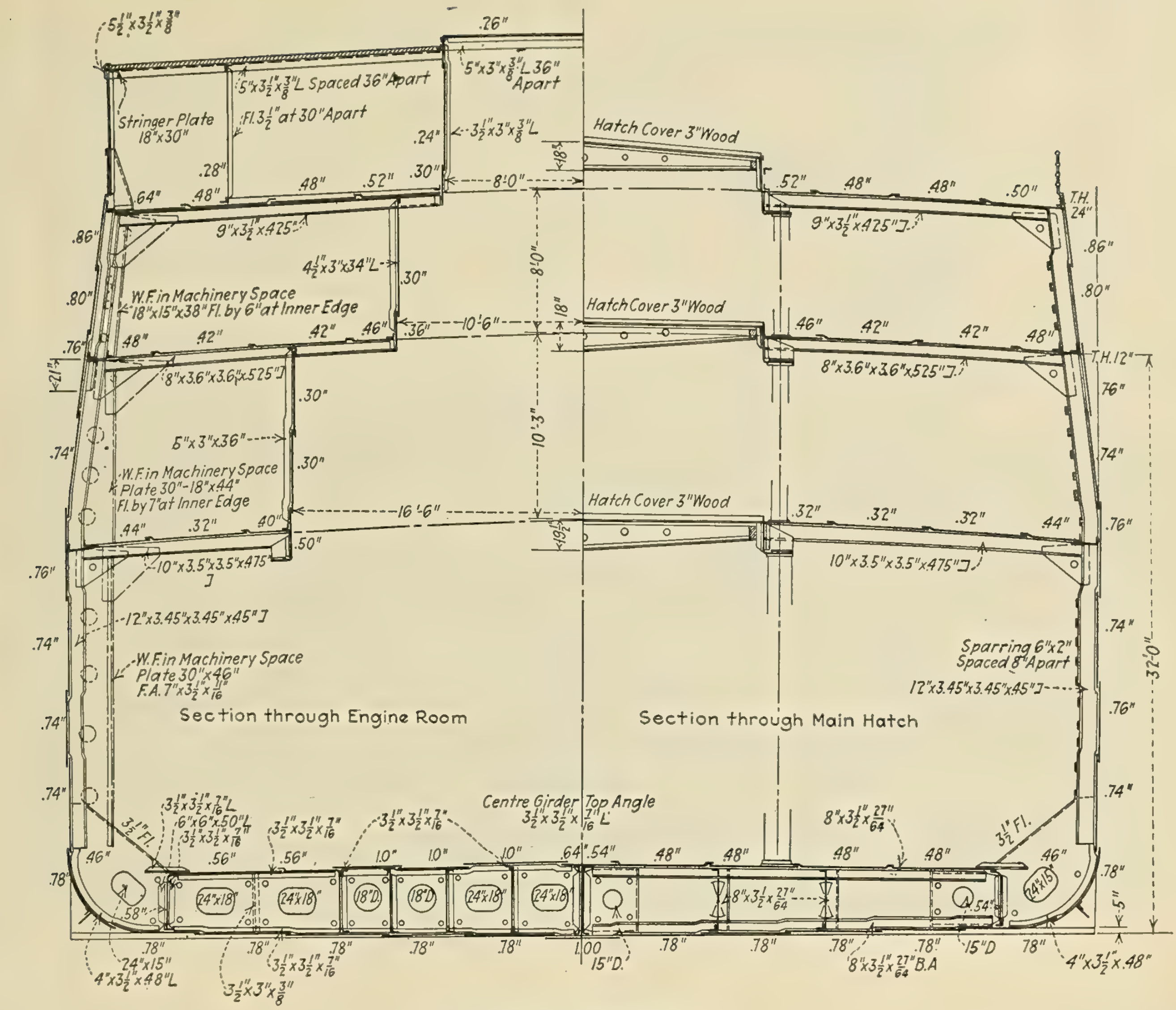


Fig. 4.—Midship Section

Anchor Handling

There is a powerful spur geared anchor windlass and a capstan engine aft for anchoring and mooring purposes. The bower anchors are of the Ohshima patent stockless pattern and are stowed in the hawse pipes.

Steering Gear

The steam steering engine is of Brown's patent steam tiller type actuated from the bridge through telemotor gears. An electrical rudder head telltale is provided so that any disturbance in the telemotor system can be readily noticed by the officer on watch. The ship has been arranged for the installation of wireless apparatus, but this has not been fitted by the shipbuilders.

Propelling Machinery

The propelling machinery of the ship consists of two sets of triple expansion engines, constructed by the Kubota Iron Works of Osaka. The particulars of each main engine are as follows:

Diameter of high pressure cylinder	22 inches
Diameter of intermediate pressure cylinder	36½ inches
Diameter of low pressure cylinder	61 inches
Stroke	48 inches

There are two main condensers, each having a cooling surface of 2,700 square feet. Each of the propellers has four detachable manganese bronze blades with a cast iron boss. The diameter and pitch of the propellers is 16 feet and 18 feet respectively.

Steam is generated by four single ended return tube boilers working under Howden's system of forced draft. The particulars of the boilers are as follows:

Diameter	14 feet 3 inches
Length	11 feet 6 inches
Working pressure	200 pounds per square inch
Grate area	58.2 square feet
Heating surface	2458.8 square feet

The engine and boiler room auxiliaries include the following:

Auxiliary condenser: One, of 600 square feet cooling surface.
Circulating pumps: Two sets, centrifugal type.
Independent feed pumps: One pair, size 10½ inches by 8 inches by 24 inches.
Independent bilge pump: One, size 6½ inches by 6½ inches by 6 inches.
Ballast pump: One, size 9 inches by 12 inches by 10 inches.
General service pump: One, size 10 inches by 6 inches by 10 inches.
Oil shifting pump: One, size 10 inches by 7 inches by 10 inches.

In addition, there is a 20-ton evaporator, an ash hoisting engine, a feed water heater, etc.

The ship is lighted throughout by electricity. Two dynamos, one of 25 kilowatts capacity and one of ten

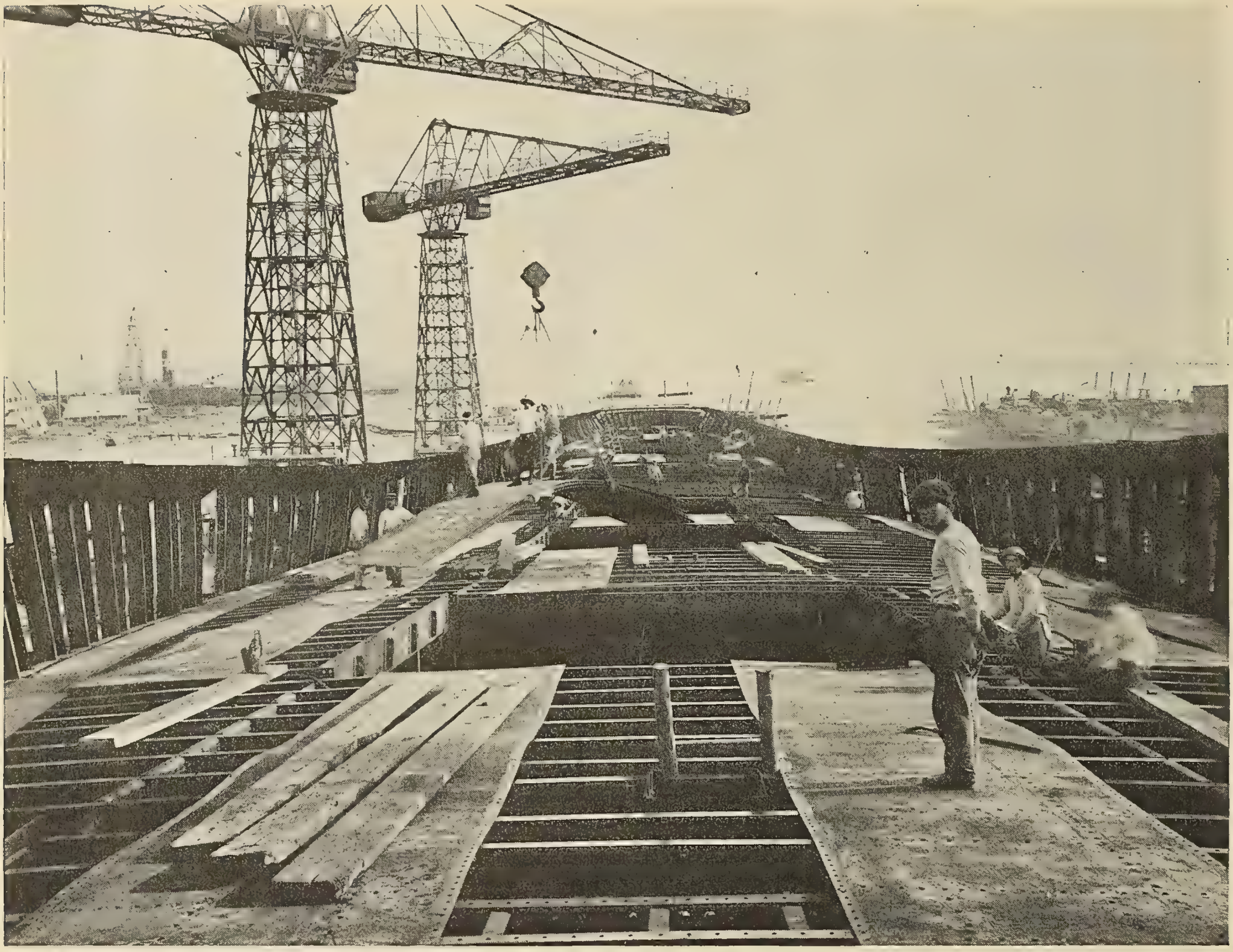


Fig. 5.—*Eastern Trader* Under Construction

kilowatts capacity, are placed in the engine room for this purpose. Space for cold storage and ice machines was provided, but these are to be installed in the United States after the vessel is delivered.

Trials

The steam trials of the *Eastern Merchant* and her sister ship *Eastern Trader* were very successful and satisfied both the owners and the shipbuilders. On the light load steam trial the *Eastern Merchant* attained a mean speed on double runs of 15.46 knots, while the *Eastern Trader* made 16.15 knots. Afterward the former ship easily made a mean of 12.7 knots on a six hours' continuous run with a total deadweight of over 11,000 tons on board, every part of the machinery being kept in normal working condition. Thus these ships proved themselves not only the largest but the fastest among the ships built in Japan for the United States Government.

The keel of the *Eastern Merchant* was laid on April 21, 1919, and that of the *Eastern Trader* on May 1, 1919. Both ships had several alterations during the construction, and were launched on October 6 and November 4 respectively. Both ships had steam trials during December of the same year and were handed over to the United States Government early in February, 1920, at San Francisco.

Steamship Eudunda Launched at Australian Naval Dockyard

A FURTHER stage in the progress of the Australian Commonwealth shipbuilding programme was reached on March 29 when the steamship *Eudunda* was launched from the Commonwealth Naval Dockyard, Cockatoo Island. This vessel is the first of the improved shelter deck type to take the water. Her principal dimensions are as follows:

Length between perpendiculars	331 feet 0 inches
Breadth, molded	47 feet 9 inches
Depth, molded to upper deck	26 feet 1 inch
Load draft	23 feet 8 inches
Indicated horsepower	2,300
Boilers (Babcock and Wilcox)	3
Speed	10½ knots

The vessel is built to Lloyd's classification on the Isherwood system of framing and has a double bottom extending from the forward collision bulkhead to the after peak. The double bottom, except under the boiler room, is arranged for stowage of oil fuel, it being anticipated that the vessel will be required to burn coal or oil during her period of service.

A complete shelter deck is fitted, thus adding considerably to the deadweight carrying capacity of the vessel,

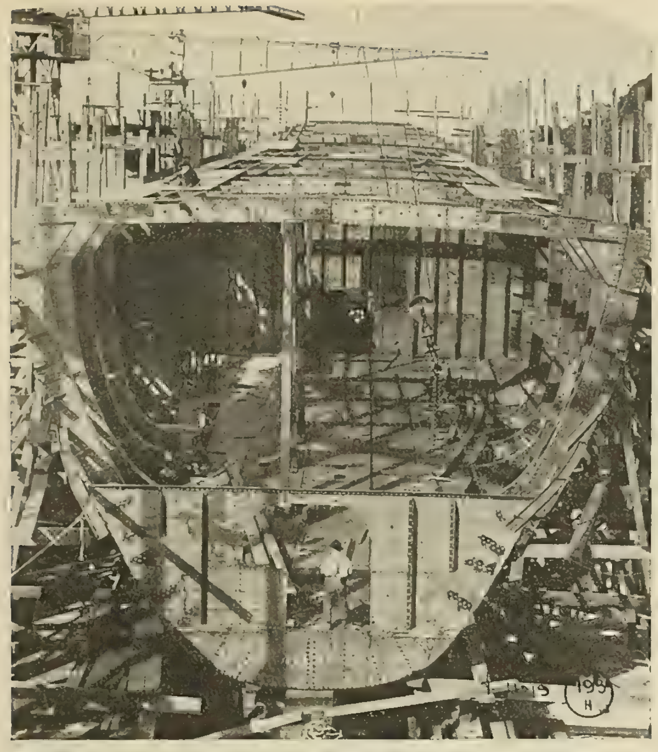


Fig. 1.—View of S. S. *Eudunda* in Course of Construction at Commonwealth Naval Dockyard, N. S. W.

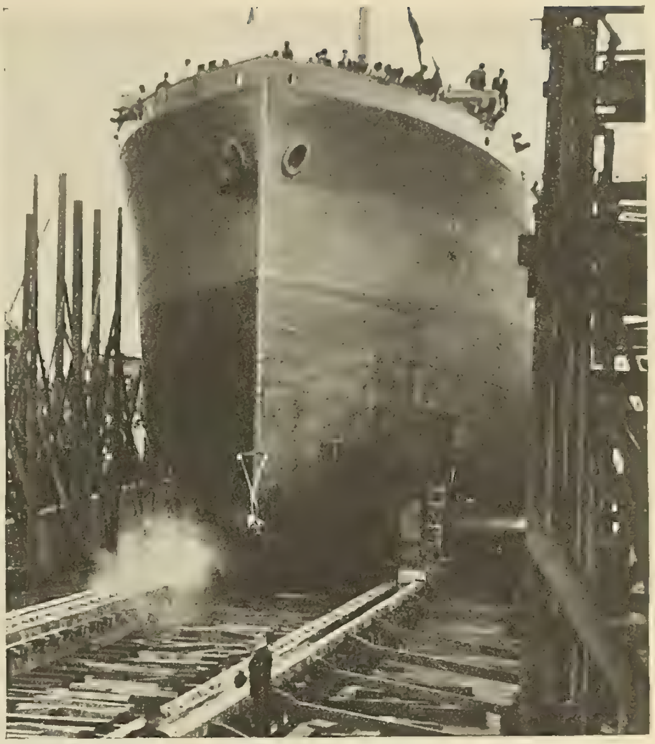


Fig. 3.—Launching of S. S. *Eudunda*, Naval Dockyard, Sydney, N. S. W., on March 29, 1920

which now becomes 6,000 tons as against 5,500 in the earlier vessels.

Accommodations throughout are arranged in accordance with the latest requirements of the Navigation Act. The officers' quarters are on the bridge deck. The captain's quarters with the wireless operator's and wireless room, are on the lower flying bridge. The seamen and firemen are berthed aft on the upper deck. The joiner work is of Australian timber and all fittings are first class throughout.

A refrigerating room for carrying of food supplies for the ship's company is installed on the upper deck. The vessel is lighted throughout with electricity and all cabins are steam heated. The piping arrangements are very complete and include an efficient system for dealing with the oil fuel.

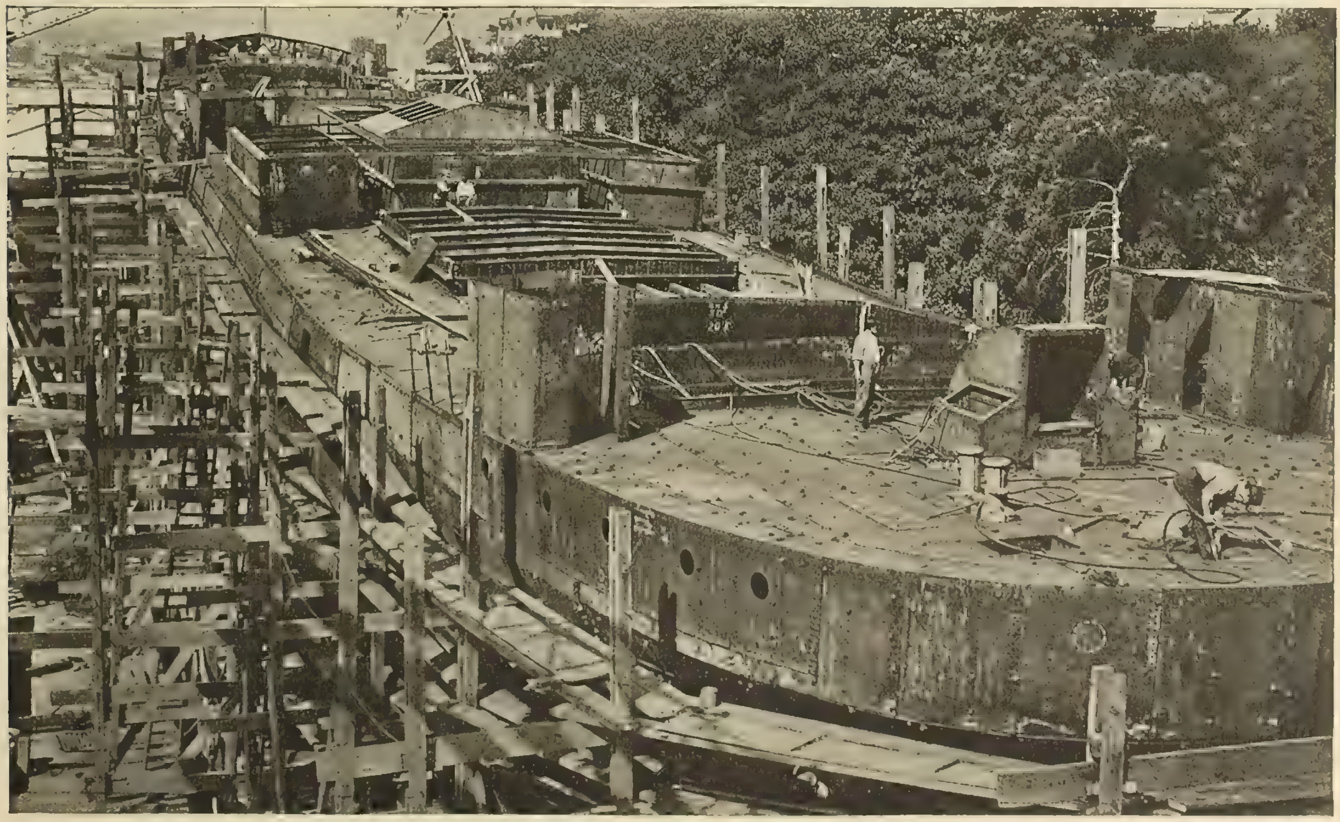
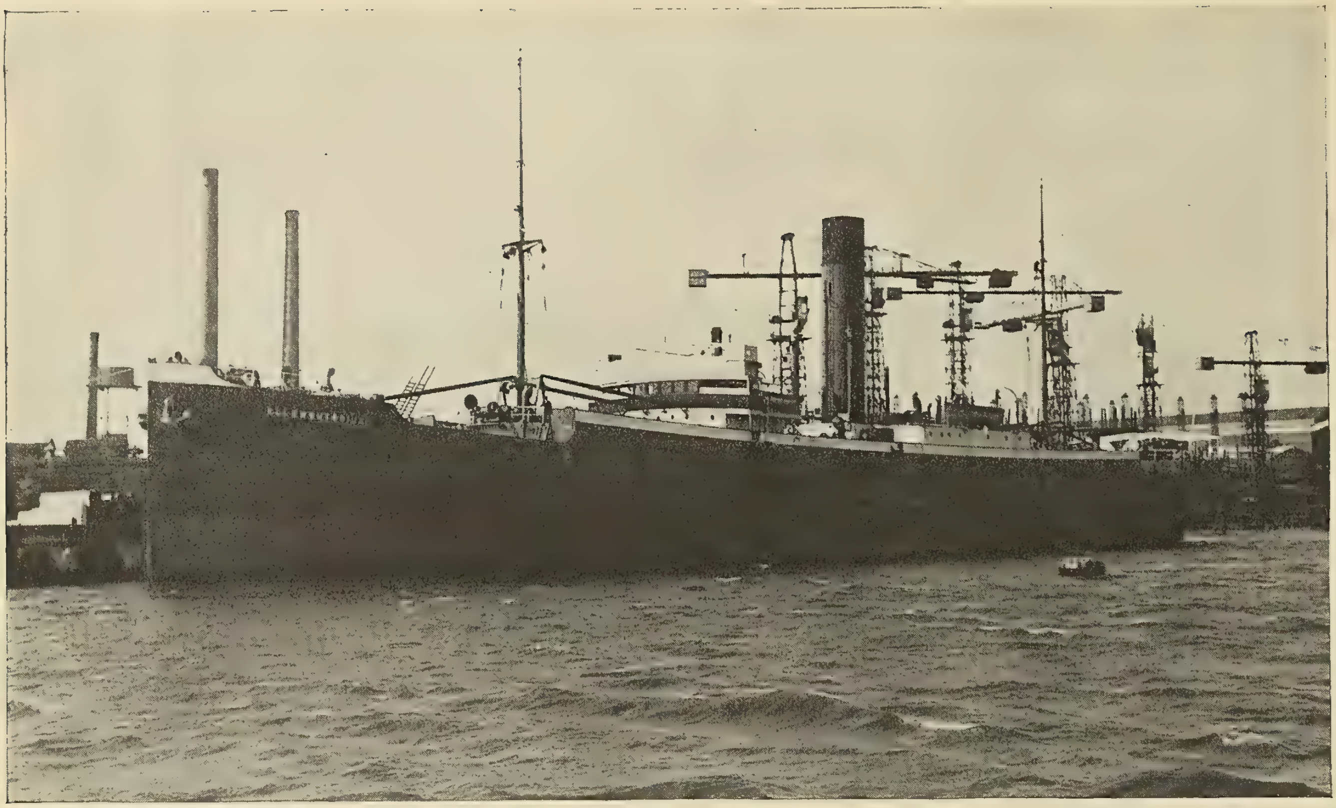


Fig. 2.—View of S. S. *Eudunda* Shortly Before Launching



S. S. *Ellewoutsdyk*, Built at Werf Gusto Works, Schiedam, Holland

Cargo is handled by eight 5-ton steel lattice work derricks carried on the foremast and mainmast and a 20-ton steel derrick, which is provided for dealing with heavy weights. Eleven steam winches are fitted, viz., eight 7-inch by 12-inch winches at main cargo hatches; one 7-inch by 12-inch winch aft, having an extended main shaft with couplings and brackets and fitted with warping drums, and two 7-inch by 12-inch winches amidships for the cross bunker hatch.

It is interesting to note that these winches, together with the windlass, steam steering gear and other auxiliary machinery and fittings are of Australian manufacture, the winches and windlass being supplied by the Perry Engineering Company, of Adelaide, and the steam steering gear by Messrs. P. Jorgenson & Sons, Bendigo. The manufacturers of the refrigerating machinery are Messrs. Wildridge and Sinclair, Ltd., of Sydney, and various makers throughout the Commonwealth are supplying the remainder of the equipment.

The engines are of the usual triple expansion vertical marine type, developing 2,300 indicated horsepower, manufactured by Messrs. Thompson & Company, of Castlemaine, Victoria. There are three Babcock and Wilcox boilers, having a heating surface of about 8,000 square feet.

New Dutch Steamship

THE latest vessel turned out by the Werf Gusto Firma A. F. Smulders, Schiedam, Holland, is the cargo steamer *Ellewoutsdyk* built for Messrs. Solleveld vander Meer & T. H. van Hattum's Steamship Company, Rotterdam. The *Ellewoutsdyk* is a single deck vessel with long bridge and poop, built according to the highest classification of Lloyd's, 100 A-1, under the supervision of the Dutch shipping and harbor authorities. She has a length of 359 feet 3 inches, a beam of 50 feet, and a depth of 24 feet 6 inches. On a draft of 21 feet 7½ inches the vessel has a deadweight carrying capacity of 6,300 tons, her gross tonnage being 3,683, and the net tonnage 2,239.

Six watertight bulkheads divide the hull into seven compartments, four of which are cargo holds. The capacity of each is as follows:

	Grain, Cubic Feet	Bales, Cubic Feet
Hold 1	76,950	71,630
Hold 2	96,570	90,530
Hold 3	58,690	54,730
Hold 4	47,820	43,330
Bridge, forward of casing	42,170	36,880
Bridge, at side of casing	10,460	8,220
Bridge, aft of casing	25,620	22,320
Forecastle	6,070	5,220
Total capacity	364,350	332,860

The bunkering capacity is 793 tons, including the spare bunker under the bridge. The capacity of the water ballast tanks, including the fore and aft peaks, is 1,130 tons.

Officers' quarters are situated under the bridge and above or along the engine casing. The crew is berthed in the poop. Separate hospitals are provided for the officers and crew.

The vessel is propelled by a triple expansion engine with cylinders 25 inches, 41 inches and 67 inches diameter by 45 inches stroke, designed to develop 1,800 indicated horsepower. Steam is supplied at a pressure of 180 pounds per square inch by three coal-fired Scotch boilers, each 13 feet 9 inches diameter by 10 feet 5 inches long. Both propelling and auxiliary machinery were manufactured at the Werf Gusto works. The auxiliaries include an electric generating set of 7 kilowatts capacity, which provides current for lighting the vessel and also for the wireless equipment.

Passenger Steamer for the Newcastle-Bergen Route

AN important event in the progress of British reconstructive shipbuilding took place on May 4 at the Walker shipyard of Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, of Newcastle-on-Tyne, when a steel screw passenger vessel for Det Bergenske Dampskibsselskab, Bergen, was launched. Mrs. Lee, Lady Mayoress of Newcastle-on-Tyne, gracefully named the vessel S. S. *Leda*. The *Leda*, which is to run between Newcastle and Bergen, forms a powerful addition to the company's fleet. She is a finely modelled steamer with slightly larger accommodation and more speed than the S. S. *Jupiter*, which up to the present has been the fastest steamer in this service.

The principal dimensions are as follows:

Length overall	321 feet 2½ inches
Length between perpendiculars	305 feet 0 inches
Breadth, extreme	41 feet 9 inches
Depth, molded	20 feet 6 inches
Mean load draft	17 feet 0 inches

The vessel is of the two deck type, with combined poop and bridge, joined to the forecastle by means of two permanent gangways, the shell being carried up in way of the forward well to the line of the forecastle. A promenade deck extends for about one-half length amidships, covering the midship house, while above this is the boat deck, at the fore end of which is placed a house containing the accommodation for the captain and principal deck officers. An after boat deck covers the house containing the steering gear, third class entrance and seamen's entrance.

Passenger Accommodations

The vessel is fitted out for about 100 first class passengers, in one and two-berth rooms, placed on the upper and second decks. These staterooms, which are large and airy, are fitted up in first class style and are in every way suitable for the comfort of the passengers. A large dining saloon is fitted up at the fore end of the bridge deck, having seating accommodation for all passengers. The main entrance of this dining saloon is carried up to the promenade deck, from which opens a spacious lounge. The decorative work and fittings of the saloon, lounge and entrances are of elegant finish, the work being designed and carried out by Messrs. Trollope & Colls, Ltd., of Liverpool. The whole of the first class accommodation is such as will appeal strongly to those crossing from Great Britain to Norway.

On the upper deck aft, accommodation is arranged for forty-seven third class passengers in two, four, five and six-berth cabins, with two comfortable dining rooms, one on the upper deck, the other in the house on the poop deck. An open air café is arranged at the aft end of the promenade deck.

Officers' and Crew's Quarters

On the bridge deck around the engine and boiler casing are housed the engineers and junior deck officers; here also are the mail room, post office, etc. Accommodation for the stewards and stewardesses is arranged at the after end of the first class accommodation on the upper deck. The firemen are berthed on the second deck at the sides of the engine casing, and the seamen on the second deck aft.

Construction and Equipment

The vessel is built to the highest class of Norske Veritas and will be the first vessel in the North Sea to comply with the requirements of the London Convention for Safety of Life at Sea. The regulations of the Norwegian Board of Trade for passenger vessels have also been complied with. Ample water ballast capacity is arranged for in double bottom, deep tanks, side tanks and fore and aft peaks, ensuring an equally good sea boat in the loaded condition. Three cargo holds are arranged, each served by double derricks and double winches, so that cargo can be quickly shipped and unshipped. The ventilation arrangements are of the most up-to-date type. The first and third class accommodation, seamen's and firemen's accommodation are ventilated and heated on the thermo tank system and arranged so that the air in each room may be continuously changed. Special insulation is fitted to keep the various rooms at a uniform temperature in the coldest weather, and also to guard against overheating from the machinery and boilers.

The deck machinery is of the latest type, the steering gear of Caldwell's make being fitted on the rudder head, with telemotor control from the wheelhouse amidships. The vessel is fitted with electric light throughout, having duplicate plants, together with emergency lighting and pumping arrangements, as required by the London Convention. Marconi wireless installation is also fitted. The cooking and serving arrangements are of the very best description, designed so that food can be well and quickly served. The various regulations to guard against fire are being fulfilled, while lifesaving appliances are in accordance with the latest requirements of passenger vessels. Lifeboat accommodation is arranged for every person on board.

Propelling Machinery

This vessel is of the single screw type, with turbine machinery driving the propeller shafting through gearing. The turbines consist, for going both ahead and astern, of a high and low pressure turbine, working in series. These turbines transmit their power through flexible couplings to pinions, which in turn drive the gearing, which is of the double reduction type. This type of gearing makes possible a speed of rotation which is best suited both to the turbines and the propeller, resulting in a high overall efficiency being obtained. At the same time, the revolutions of the propeller are about the same as would be obtained by machinery of the reciprocating type, the total reduction of speed between the turbines and propeller being effected in two steps.

When working at full power on service it is anticipated that the turbines will develop about 2,800 shaft horsepower at about 115 revolutions per minute. The impulse type of turbine having wheel stages throughout has been adopted; the grouping is such as to produce practically an equal transmission of power through the high and low pressure turbines. The adoption of high and low pressure turbines for going astern produces an arrangement which is conducive alike towards greater efficiency and immunity against total breakdown. The rotating portions of the turbines comprising the stage wheels and the spindles have been made entirely from ingot steel forgings, while the blading throughout is of phosphor bronze material.

The gear wheels and pinions are of the double helical type, the shape, size and pitch of teeth being made in accordance with what experience has proved to be satisfactory. The wheel rims upon which the teeth are cut, together with the main shafts, are made from ingot steel forgings, while the pinions are of nickel steel.

Lubrication and Auxiliaries

For the efficient and silent running of such gearing it is necessary that the means of lubrication should be as thorough as possible. For this purpose sprayer nozzles, distributed at suitable intervals, are arranged to spray

the oil direct onto the engaging teeth, thereby providing a film of oil between the surfaces in contact. All other bearings in connection with the turbines and gearing also work under a system of forced lubrication.

The Michel type of thrust bearing is used both in connection with the adjusting of the high and low pressure turbines and the main thrust block.

The condensing plant is made capable of maintaining a vacuum of 28½ inches, with the temperature of sea water at 60 degrees F. when the machinery is developing its full service power. A very complete installation of auxiliary machinery is provided to cope with the whole of the engine room and deck requirements of a vessel of this class. This includes an auxiliary condenser of suitable size.

Boilers

The boilers are of the multitubular type, single ended and three in number. They are arranged for working with Howden's system of forced draft. The working pressure of the boilers is 220 pounds per square inch. An approved type of superheater is fitted in connection with the boilers, and the temperature of the superheated steam entering the turbines is about 200 degrees F. in excess of saturated steam. Special attention has been paid to the provision of suitable materials which come in contact with the superheated steam, both in the boiler and engine rooms, and considerable attention has been given to the insulating of all hot surfaces, by the provision and application of special non-conducting materials. A fan arranged for driving by two engines, one being a stand-by, is fitted for supplying the air for the forced draft. The stack is of oval section with outer casing, which is carried the full height.

Ample and well directed ventilation is provided for both the engine and boiler rooms. The machinery throughout has been built to the Norwegian Veritas classification for a passenger vessel, and it also complies with the requirements of the London convention. The new vessel will be a great acquisition to the owners' fleet, and will without doubt rapidly become popular with the traveling public.

Vessels of the Forest Lumber Fleet

Five-Masted Barkentine Rigged Sailing Vessels, Especially Designed for Lumber Trade, Being Built in Pacific Coast Yards

THE wooden sailing vessel, because of its comparatively low operating cost, still has a section of the carrying trade almost exclusively for its own. Where the time element does not enter the question of transporting a cargo, the sailing vessel enters the field in fair competition with the steam- and the motor-driven ship. In the case of lumber carrying, this fact is particularly true, and many ships are at present building along the Pacific Coast to engage almost entirely in this traffic.

Recognizing the commercial value of the sailing vessel in the lumber-carrying trade, the Forest Line, controlled by the Grays Harbor Motorship Corporation, Aberdeen, Wash., has recently added to its fleet several of what are considered the last word in wind-jammer freighters.

The vessels were designed by M. R. Ward, the vice-president and general manager of the corporation, who during the war produced what was known as the "Ward Type" ship, one of the most efficient of the wooden vessel types adopted by the Emergency Fleet Corporation. The design is the result of a careful balancing of the various requirements of a lumber-carrying vessel which have been found by experience necessary in this trade.

General Details of Construction

Among other notable deviations from general practice in construction, the design incorporates a series of steel reinforcing frames at the turn of the bilge. These reinforcements, consisting of ¾-inch by 14-inch steel plates averaging 13 feet in length, are placed on every third frame for about three-fourths of the vessel's length. For final installation the plates are bent to the proper curvature and bolted through the wooden frames. To further strengthen the members, 6-inch by 6-inch by ½-inch angle irons are riveted to the steel plate, and after the vessel is ceiled a ½-inch strap is bolted through the ceiling to the angle irons by means of two bolts in each strake.

The Ward design also includes an arch keelson built up to the height of the 'tween decks. Both the above features contribute materially in reducing the weight of the other members entering into the construction of the hull, thus increasing both the bulk and deadweight carrying capacity of the vessels.

Machinery Installed

There is one winch in the donkey house forward of hatch No. 1, mounted on the same frame with a specially constructed Lloyd's tested 54-inch donkey boiler. There is also one winch forward of hatch No. 2. With this handling gear very fast time for a sailing vessel can be attained in handling lumber; in fact, in loading the *Forest Pride*, a vessel of the type described above, it was demonstrated that under reasonably favorable conditions as much as 200,000 board feet of lumber could be loaded in eight hours.

Mounted athwart the top of the donkey house, at the after end, is a 3 15/16-inch shaft carrying two gypsy heads, which can be driven either from the winch in the donkey house or from a 12-horsepower standard distillate engine, through a specially constructed reduction gear. The gear ratio between the engine shaft and the gypsy shaft is eight to one, giving a speed of about 40 revolutions per minute on the heads when the engine is turning at its rated speed. This results in a purchase at the gypsy heads that makes possible the handling of the heaviest loads, even to weighing the anchors. In utilizing the heads for this purpose in an emergency it is necessary to connect them to the windlass by means of a messenger chain. The distillate engine is also used to drive a Liverpool pump installed just aft of the engine house, connection also being made through a messenger chain.

An ample water supply is provided in the form of two 3,000-gallon tanks placed on the 'tween decks, just aft of the chain locker, and immediately aft of these is located a 6-inch by 4-inch by 6-inch duplex general service steam pump, which may be used for pumping bilge or for fire protection. This pump is reached from a hatch located in the sailors' quarters in the forecastle. Between hatches 2 and 3 two hand deck pumps with cylinders 7 inches by 5 inches are installed as low as possible. There is also one portable hand deck pump provided with the necessary

Barkentine-Rigged Ship *Forest Pride* Built for the Lumber-Carrying Trade Between Pacific Coast Ports and the Far East

suction and discharge hose. A Fairbanks-Morse electric lighting plant, placed aft, where it can be given continual attention, provides ample lighting capacity.

The behavior of the *Forest Pride,* which recently left for Australia with a lumber cargo exceeding 1,665,000 board feet, indicates that these vessels will need but little ballast to carry heavy cargoes of lumber and none whatever to trim them fore and aft.

A Double Decked Automobile Ferry with a Winton Diesel Electric Drive

BY RENWICK Z. DICKIE*

THE problem of automobile transportation over water is becoming acute and much interest is manifested in the design of vessels for the carriage of motor vehicles. Up to the present time no radical departure had been made in the design of these vessels or their power plant, as in most cases boats that were formerly used for other services have been converted into automobile ferries.

From the standpoint of the hull, a vessel of certain fixed dimensions could have its capacity increased nearly

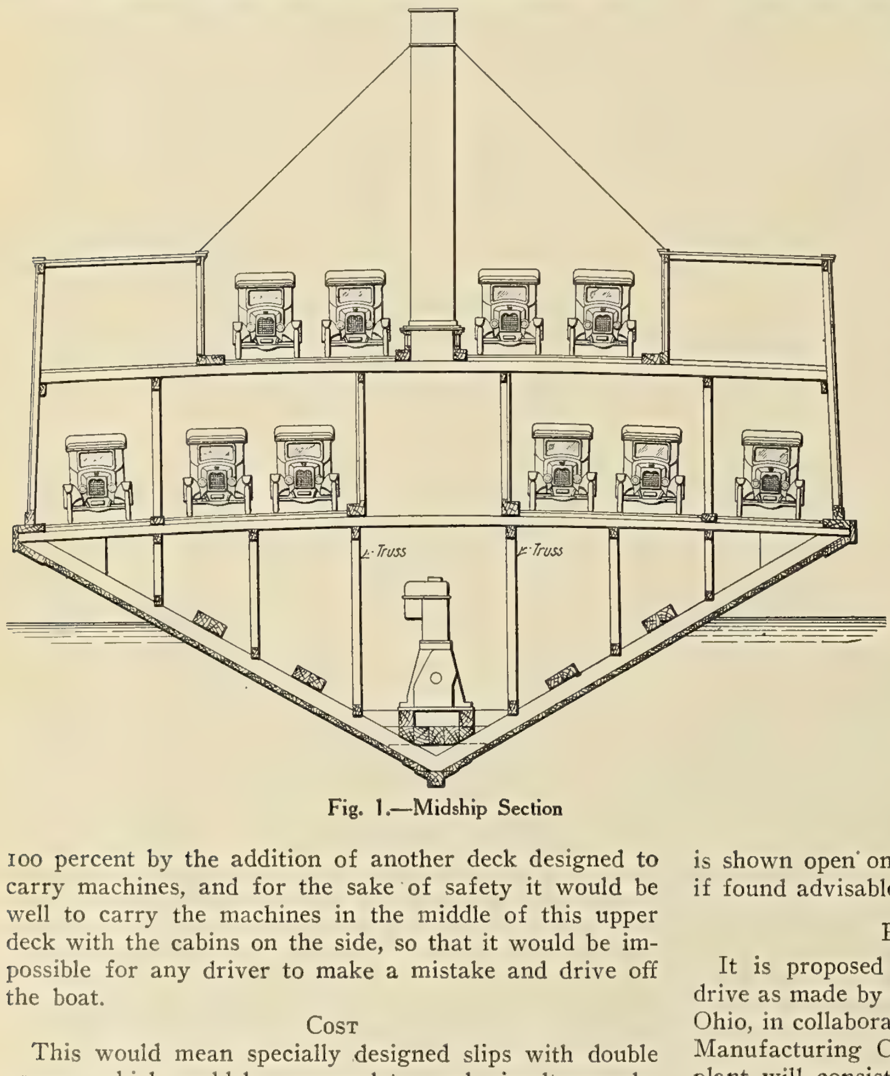


Fig. 1.—Midship Section

100 percent by the addition of another deck designed to carry machines, and for the sake of safety it would be well to carry the machines in the middle of this upper deck with the cabins on the side, so that it would be impossible for any driver to make a mistake and drive off the boat.

Cost

This would mean specially designed slips with double aprons, which could be arranged to work simultaneously. The main deck should be made to fit the slips which are now in use, so that the boat could be used temporarily in another route if necessary. To double the capacity of the boat in this way would involve a 20 percent increase in the cost of hull, decks and houses, while the increase in cost of the slips would be about 50 percent. Many projects which are contemplated in the present day founder on their first cost due to the high cost of material and labor. In starting a new project the ideas o fthe principals are so expensive that it is impossible to carry them out and make a paying proposition.

Type of Ferry

In Marine Engineering, December, 1913, a steel ferry boat called the *South Jacksonville* is shown using a V-bottom of the simplest type of construction. This boat was designed and built by Merrill-Stevens Company, Jacksonville, Fla., for the Jacksonville Ferry and Land Company, and is the result of the experience with a wooden steam ferry called the *Duval,* designed and built by the same builders some time ago, which has proven highly successful in service. It is our intention to use this simple model, thereby reducing the weight and the cost of the hull, this type lending itself very readily to ferry boat design, as a normal ferry boat hull has a block coefficient of 0.4 and the displacement and stability increase very rapidly as the boat is loaded.

Description

The sketches show a double deck automobile ferry 205 feet long overall, 191 feet long between perpendiculars, and 44 feet beam, with a breadth over the guards of 68½ feet. Accommodations for the crew, not shown in sketch plans, will be arranged in the under deck space adjoining the engines. The upper deck is shown open on plans, but it can be easily roofed over if found advisable.

Propelling Machinery

It is proposed to install a double end screw electric drive as made by the Winton Engine Company, Cleveland, Ohio, in collaboration with the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., and the plant will consist of two 500-horsepower, 8-cylinder engines. Each one is directly connected to a generator, which in turn drives a motor connected to a propeller at each end, turning at 135 revolutions per minute.

Each driving motor will be operated independently of the other, and this will give an opportunity of getting data as to the gain, if any, of operating these propellers at different speeds, as it is generally believed that a screw

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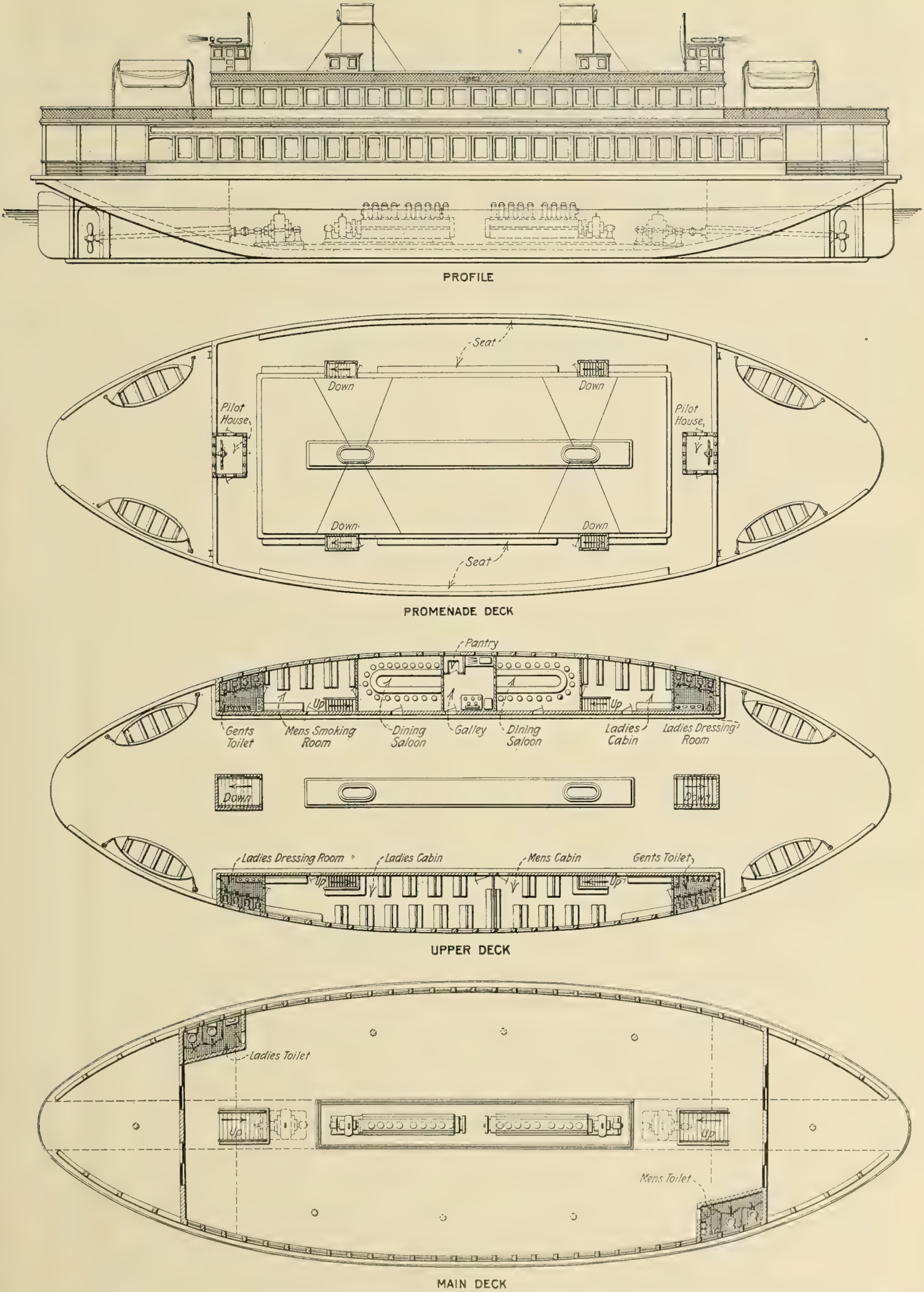

Fig. 2.—Profile and Deck Plans of Double Deck Automobile Ferry. Length Overall, 205 Feet; Length Between Perpendiculars, 191 Feet; Beam, 44 Feet; Beam Over Guards, 68 Feet 6 Inches; Horsepower, 1,000

ferry boat would give higher propulsive efficiency if the propeller at the stern were driven faster due to its working partly in the wake of the forward propeller. The driving motors will be designed large enough to take an overload of at least 50 percent when starting and stopping, and the control of the field current will be arranged so it can be reversed, and, if deemed advisable, this control can be at the hand of the navigator in the pilot house.

Auxiliaries

All the auxiliaries, such as steering gear, sanitary, fire and bilge pumps, can be handled from the main power plant, as they will all be motor driven. An auxiliary generating set of 30 kilowatts capacity will be fitted to take care of the lighting and pumps while the vessel is in the slip.

In comparing this electric installation with propulsion by a steam beam engine, it is assumed that two electricians can properly care for the plant and that their wages would just offset the wages of the firemen in the steam plant.

Comparison with Beam Engine

For the sake of comparison, it is assumed that the boat will be in operation for sixteen hours a day and will be in the slip about eight hours.

	Diesel Electric Drive	Beam Engine Jet Condensing Plant
Indicated horsepower	1,000	1,000
Weight of plant installed, tons	200	250
Fuel used per hour per horsepower	.45	2.
Fuel used per hour, barrels	1.7	4.7
Fuel used in barrels per day running 16 hours	27.2	75.2
Fuel used per hour in slip, barrels	.25	.25
Lubricating oil used per day, 16 hours running, gallons	18	6
Lubricating oil used per hour in slip, gallons	.75	.25
Hours running	16	16
Hours in slip	8	8
Cost of lubricating oil per gallon, cents	.29	.43
Cost of lubricating oil per year	$2,540.40	$1,255.60
Cost of fuel oil per barrel	$1.85	$1.60
Cost of fuel oil per day running	$50.32	$120.32
Cost of fuel oil per day in slip	$3.70	$3.20
Water used per day for power plant, tons		25
Weight of water carried in tons for power plant		50
Cost of water, at 10 cents per ton, per day		$5.00
Fuel used per year, in barrels	10,658	28,178
Water used per year for power plant, tons	00	912
Cost of water per year		$912.00
Total cost of fuel, water and lubricating oil for 1 year	$22,240.00	$47,267.60

It will be seen that there will be a saving of about $2,000 a month in the cost of operation of the power plant through the saving in fuel, water and lubricating oil, and besides this the boat can handle nearly twice as many machines as a single decked automobile ferry.

Ships, Past and Future*

BY FRANK E. KIRBY, CONSULTING ENGINEER

In early days the ports along the New England coast were largely interested in deep-sea shipping. In fact, it was the most profitable business of Portsmouth, Newburyport, Gloucester, Salem, Boston, New Bedford and other smaller ports. The ships flying the American flag traded in all the ports of the world. About the only evidence of their former activities to be seen now is in the museums in those towns, where there are models and pictures of ships, nautical instruments and other interesting articles pertaining to the ship business.

The shipping business prospered in those ports up to the beginning of the Civil War, reaching its highest efficiency during the clipper ship era in the fifties, following the discovery of gold in California. During that period the United States led the world in the character of its merchant ships, but a great change was coming. The introduction of steam power in ships, which was rapidly developed in Great Britain, after first being tried by America, provided more certain, rapid and economical transportation, though for many years the sailing ships held their own, particularly for long voyages, due to the use of the paddle wheel propeller. The introduction of the screw propeller, particularly in iron and steel ships, finally ended practically the domination of the sailing ship. Excepting Boston, the New England ports took no part in the development of steam ships. New York became the principal port for steamers. American lines were established to Great Britain, France and Germany. The ships were propelled by paddle wheels and, like our sailing ships, were the best in the world.

Through the failure of America, and particularly of New York, to appreciate the screw propeller, notwithstanding it was introduced into this country by Captain Ericson contemporarily with its introduction into Great Britain, our ships were finally driven from the seas. A last chance was attempted by Boston about 1860, I think. They built two screw steamers for the Liverpool service, the *Merrimac* and *Mississippi*. I am not sure either one of them ever made a voyage to Liverpool; however, they were utilized by the Government during the Civil War for transports and did good service.

After the war I think one of them ran to Bremen for a while and afterwards to Panama. They were built of iron and were fairly up to date at the time of their construction, though they proved weak in some particulars.

The next attempt with screw-propelled ships was more successful. The American liners *Pennsylvania, Illinois, Ohio* and *Indiana* were built by Crane at Philadelphia about 1871 or 1872 for service between that port and Liverpool. They had iron hulls and compound engines. They continued in service for nearly twenty years and were followed by the well-known ships *St. Louis* and *St. Paul* and some others for service to Antwerp. The results of their operations can be judged by the fact that the company has not built any new ships for many years.

I want particularly to emphasize the fact that America did not appreciate the importance of the screw propeller as a factor in the development of sea-going ships, and later we were slow to appreciate the value of the compound engine, although early adopted in this country. We have taken more kindly to the turbine, due principally to necessity on account of the late war. And now, are we awake to the value of the "Diesel" motor or the possibility of the "Still" motor?

To recapitulate, the screw propeller, the compound engine, the Diesel or Still motors mean economy. It should be spelled with capital letters, without which we cannot compete, no more than any manufacturer with obsolete tools; not only must we use economical tools, but we must produce them economically. In short, we must build ships at less cost than any other people if we are to lead. It is a fact that this country has the greatest natural advanages in the supply of raw materials that enter into the construction of ships, and some explanation and apology is due if we can't build ships at less cost than any other people. Some say it is the high cost of living that prevents us from building ships at low cost, and that calls for another explanation, and why, when we have the greatest natural resources for supply of food, and all other necessities of living, it costs more to live in the United States than anywhere else in the world. We would not like to admit that it is because we don't know how to build ships or how to live. But why can't we do it? We can, but will we? That is the question.

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* From *Speed Up*, published by the Submarine Boat Corporation, Newark Bay, N. J.

Some Pertinent Remarks

BY "OLD SCOTCH"

WELL, we are on the map at last! The Merchant Marine Act, 1920, which was approved June 5th last, may well be named the "Maritime Declaration of Independence" for the United States. The preamble of our sacred national bill of rights might well be paraphrased something like the following:

"When, in the course of human events, it becomes necessary for one people to disolve the *shipping dependency* which has bound them with another, and to assume among the *maritime nations* of the earth the separate and equal *rights on the seas* to which the laws of Nature and of Nature's God entitles them............"

Senator Jones and Congressman Greene might well be called the Thomas Jeffersons of the period, so far as this maritime declaration is concerned.

An American Act Through and Through

The act is American through and through, and if we cannot make good with such liberal legislation on the statute books we may as well give up further attempts and admit that it is our own fault that we do not keep the ships going. This law stops short only of a direct subsidy, but later, if it is found necessary to resort to that method of running our ships, the now anounced policy of the Government will admit of even that extreme. Let us all pull together and hope that we can get along without it!

Although the measure passed the House originally with but few votes in opposition and was put through the Senate without even the formality of a roll call, when it got in conference real opposition began to develop. Under very thinly disguised subterfuges representatives of foreign interests began insidious attacks, which, but for splendid generalship on the part of the managers of the bill, might have resulted in the defeat of the measure, or at least a serious crippling of its important features.*

Such opposition no doubt originated among our rivals to protect their own interests as they see them. However, our viewpoint is decidedly different, and we have only been demanding what we know to be our rights. To show how our efforts are considered on the other side, we can quote the following extract from a speech made by a member of Parliament, when he said:

As Others See Us

"At all costs our maritime supremacy must be maintained. American shipping has been due to emergency methods carried on regardless of expense, placed in the hands of people lacking knowledge or experience of shipping management, and based on a system of costs so high as to make economical operation an impossibility."

Perhaps in light of the above it is due to the affection which our English cousins bear for us that they do not want to see us lose our money in shipping. However, I do not think that such solicitude will deter many of us from doing "our darndest" to make things go. Just the same we might all take heed of what this worthy member says about running ships "regardless of expense." Heretofore that statement has been only too true, and, as I pointed out in the June number, it is time we took heed of this recklessness and put on the economy brakes.

Among the most beneficial clauses of the new legislative act are:

Beneficial Clauses of the Shipping Act

The first step towards providing discriminatory duties on goods imported in the United States, to favor American vessels. It appears that under the Underwood tariff act there is already a law on the statute books whereby goods imported in American vessels will have the benefit of 5 percent less duties. All that is needed is the repeal of certain treaties which is now authorized.

The arrangement of a satisfactory system governing mortgages to encourage citizens to invest their earnings in ship securities.

Exempting marine insurance companies from prosecution under the anti-trust law if they form pools or syndicates to control the business in this country.

The limitation of the coastwise trade to American built and owned vessels, with certain modifications for foreign built vessels now in control of American interests, and the extension of these laws to our insular possessions.

The authorization for the Shipping Board to extend financial help to the builders of new vessels of desirable types, to the extent of $25,000,000 annually for a period of five years. The Senate intended this to be $50,000,000 annually, but in conference it was cut in half.

The permission to fix lower railroad rates for goods imported or exported in American vessels. This clause may be made of the greatest help when competition for the world's trade becomes as keen as it was in pre-war days.

Sale of Government-Owned Ships

The requirements under which the ships now belonging to the Government may be disposed of are not such as meet the hearty approval of the shipbuilders, but with good judgment on the part of the new Shipping Board the selling of the ships may be made under such terms that will not necessarily preclude the placing of new orders in the shipyards, as has been feared by the builders.

So much depends upon the ability and integrity of the new board for the proper enforcement of the entire act that we are all hoping that none but capable and broad-minded men will be appointed. Some good upstanding "tight wads" are needed on the board about as much as any other pre-requisite. When we get members of this board who will be as careful in spending government money as they are in doling out their own, we need have but few fears of the ultimate success of our shipping ventures.

A Shipping Board Commissioner from the Interior

Such a qualification might have been put in the law as many other qualifications were specified, including a limitation as to how many of any political faith could be named. As one of the seven new members is required to be from the interior and to have a knowledge of shipping, some remarks were made to the effect that such a man would be an anomaly. However, there is a shining example of the right kind of a man to fill these requirements in the person of Secretary Alexander of the Department of Commerce. Being from Missouri and adopting the state policy of "show me," probably accounts for the splendid mental equipment this gentleman has for a posi-

* According to late reports which have leaked out, pressure was even brought at the White House to have the President veto the bill, but as Mr. Wilson has consistently favored the upbuilding of the American merchant marine, both before and during his incumbency of the Presidency, his approval was given to the measure, despite all opposition.

tion on the Shipping Board. Everyone I know of hopes that in some manner or other arrangements may be made whereby he can go on the Board.

Exempt American Vessels from Panama Canal Tolls

Senator Borah had the right idea when he introduced a bill in the Senate at the close of the session to exempt American vessels from Panama Canal tolls. This is one of the objects for which this great waterway was built, and the underlying reasons why our vessels were deprived of this benefit are now so well understood that the sooner such restrictions are removed the better it will be for the future of the American merchant marine. Let us hope the bill will have favorable action by Congress at its next session.

Another job awaiting Congress for the benefit of the merchant marine is the revision of our navigation laws. The committee of experts appointed by the Shipping Board has made its report on needed changes, and it is now understood that the laws are being re-codified by a committee of legal experts, also appointed by the Shipping Board. The so-called Franklin committee has, so we are advised, definitely determined that there is no discrepancy in the measurements for net tonnage on American built and owned vessels as compared with similar measurments on foreign vessels. This is one important controversial point settled at any event.

The Shipbuilding Outlook

Things do not look so roseate to our shipbuilders just now, which must, of course, be expected. Our present facilities in this country are more than sufficient to build all the tonnage for the entire world, which, naturally, we cannot expect to get. There are, therefore, many new yards throughout the country which must soon go out of business. Hog Island, the largest of them all, is booked to close down in the early autumn, and many others will soon follow.

It is difficult for us to realize how rapidly existing shipbuilding orders are being completed. In Shipping Board vessels alone over 850,000 gross tons of ships were delivered this year up to May 1. At this time the tonnage building for private account—that is, of ships ordered since the armistice—exceeds that of ships building for the Shipping Board. At the present rate of progress there will not be more than perhaps 250,000 tons of government owned merchant ships under construction by January 1 next.

There has been a woeful lack of new orders for private account during the past two months; this, however, may be attributed to two causes, rather than to lack of demand. Money conditions form the primary cause, while the other is undoubtedly the uncertainties which always inflict business interests during a presidential year. With the election of a President who will be deemed safe and sound by the financial interests, and with the disposal of certain undesirable tonnage abroad by the Shipping Board, it is only reasonable to expect that the years 1921 and 1922 will witness busy times in such of the American shipyards as have been able to withstand the slackening up period which we are now going through and which was inevitable from economic conditions.

Ship Repairing Steadily Increasing

While new building is decreasing, the amount of ship repairing is steadily increasing on account of the number of new ships placed in operation. This will provide work for many of the shipbuilding plants which have foreseen this condition of affairs and have added to their ship repair facilities. The Martin-Gardiner syndicate, which is to furnish the surveying and engineering talent for supervising all repairs to Shipping Board vessels, either owned or controlled by the Government, which amount to over $10,000 on any particular ship, is nearly ready to commence operations, with its main office at 23 Liberty street, New York. The object of this syndicate is to promote uniformity and economy in all ship repairs, and from the high standing of the gentlemen to whom this task is entrusted there seems little doubt but that the Board has acted wisely in making this arrangement. This syndicate will also supervise the authorization of all kinds of supplies and stores for the operation of the vessels.

Naval Construction

In looking over the shipbuilding field it must not be forgotten that despite the fact that Congress has failed to make authorization for many new vessels for the Navy during the past two years there are still about 175 new warships of all classes, ranging from sea-going tugs to first-class battleships, and costing hundreds of millions of dollars, under various stages of construction. As some of them are not scheduled for completion for over two years, the Navy work will continue to be an important factor in shipbuilding for some time to come. It is regrettable that Congress failed to authorize the construction of the seven type *B* Hog Island ships for aviation purposes, which were recommended by the Navy Department and passed by the Senate.

Conversion of "Kil" Class Gunboats Into Cargo Steamers

EIGHT British patrol gunboats of the *Kil* class, each 170 feet long between perpendiculars, 20 feet 10 inches beam, and 16 feet 6 inches molded depth, are being converted by J. Samuel White & Company, Ltd., East Cowes, Isle of Wight, into coastal cargo boats. These vessels are the *Kilmelford, Kilmarten, Kilmuckridge, Kildavin, Kilmead, Kilmallock, Kilmore* and *Kildorry*, the majority of which were built by Smith's Dock Company, Middlesborough.

The conversion is being carried out in compliance with British Corporation rules, Class B.S.*, and the work in each case includes the straightening of the stem, as the boats are double enders, and the building of a forecastle. All of the vessels are equipped with two boilers. The forward one in each case is being removed and the space fitted out as a cargo hold. The existing triple expansion engine will remain in its original position and will give a speed of about 10 knots.

As rebuilt, the vessels will have a deadweight capacity, including bunkers, of 650 tons. The forward cargo hold, which is served by a hatch 38 feet by 19 feet, will have a capacity of 23,000 cubic feet, and the aft hold, served by a hatch 22 feet by 11 feet, will have a capacity of 5,900 cubic feet. The coal bunker capacity will be 80 tons.

Two steel masts are to be fitted to each vessel and a 3-ton wood derrick will be fitted on each mast; a cargo winch 6 inches by 10 inches will be fitted at each hatch.

Provision will be made for the accommodation of 19 officers and men in each vessel. The crew will be berthed under the forecastle. The side plating amidships will be extended to enclose the bridge space, where accommodations will be provided for the officers on the main deck and for the chart and wheel house on the bridge deck.

From start to finish the work of conversion will require about two months for each ship.

New Matson Freighters to Be Fitted with Geared Turbines

The two new freighters being built for the Matson Navigation Company at the yards of the Moore Shipbuilding Company will be 497 feet long overall, have a molded beam of 62 feet and a deadweight capacity of 14,000 tons at a draft of 30 feet. They are specially designed for the rapid and economical handling of cargoes, the machinery being placed aft and the holds arranged with minimum obstructions and a maximum of hatches and ports.

The propelling equipment of each ship will consist of a 5,000 shaft horsepower Westinghouse turbine, consisting of a high pressure and a low pressure element which will drive the propeller through a common floating frame gear. This gear is to be of the double reduction type, reducing the turbine speed of 3,500 revolutions per minute to 95 revolutions per minute—a ratio of about 37 to 1. The speed of the ship will be 12½ knots.

Main Turbines

Each turbine element can be operated separately, if the other is out of commission, and both contain astern elements giving 40 percent of ahead power. Additional nozzles are provided on each turbine to permit of an increase of 20 percent of the turbine's power in case either steam pressure or vacuum (or both) should fall below normal.

The boilers will be oil fired and will carry a steam pressure of 225 pounds. The superheat will be 50 degrees and the vacuum 28½ inches.

In addition to the turbines and gears for these vessels, the Westinghouse Company will also furnish the air ejectors, air separators, condensate pumps and other auxiliaries. The condensers in each ship will have a total cooling surface of 10,500 square feet, designed to maintain the required vacuum for most efficient operation.

Steamship Cristobal Rebuilt at Panama Canal Shops

The steamship *Cristobal* of the Panama Railroad Steamship Line has been rebuilt by the Mechanical Division of The Panama Canal. The vessel was sent to the Balboa shops in May, 1919, for general reconstruction. Every part that was worn was replaced, from hull plates to the railing around the deck. The system of coal-burning boilers was changed to oil burners, with a general reconstruction of the burner and boiler spaces. New boilers were installed, and all worn parts of the engines, main and auxiliary, replaced with new. The capacity for cold storage was increased to over 13,000 cubic feet. The passenger accommodations were renovated and increased so that she can now accommodate approximately 150 first class passengers.

S. S. *Cristobal*, Rebuilt in Panama Canal Shops, Leaving Pedro Miguel Lock on Way Through Canal to the Atlantic

Public Rooms Finished in New Wood

A new smoking room, social hall and dining room were built and finished throughout in *caoba blanca,* or the light mahogany of Panama. This is a kind of wood never used prior to 1917 and unknown commercially outside of the local uses on the Isthmus and in the shops of the Canal. It possesses an unusual beauty in grain and color and offers an excellent surface for the most artistic finish in cabinet work. Practically all of the ship above the main deck is entirely new.

The *Cristobal* is a ship of 9,332 gross tons, 489 feet 6 inches in length by 58 feet beam, and 28 feet 10 inches depth. She was built in 1902 at Sparrows Point, Md., and purchased in 1909 by the Panama Railroad Steamship Line for $850,000. Today her value is estimated at around $3,000,000.

After the completion of the installation of furnishings in New York, the *Cristobal* will go back on the run of the Panama Railroad Steamship Line between New York and the Canal Zone.

Prominent Members of American Steamship Owners Association

(1) H. H. Raymond, President, Clyde and Mallory Lines; President, American Steamship Owners' Association. (2) Edward J. Barber, President, Barber Steamship Lines, Inc.; Vice-President, American Steamship Owners' Association. (3) Winthrop L. Marvin, Vice-President and General Manager, American Steamship Owners' Association. (4) Alfred Gilbert Smith, President, New York & Cuba Mail Steamship Company; Chairman, Committee on Depreciation, American Steamship Owners' Association. (5) P. A. S. Franklin, President, The International Mercantile Marine Company; Member, Executive Committee, American Steamship Owners' Association. (6) Captain Eugene E. O'Donnell, Manager, Marine Department, C. H. Sprague & Son, Boston; Chairman, Committee on Wages and Working Conditions Aboard Ship, American Steamship Owners' Association. (7) Franklin D. Mooney, President, New York & Porto Rico Steamship Company; Member, Committee on Managing Agency Agreement, American Steamship Owners' Association (Photograph Copyright by Underwood & Underwood Studios, N. Y.). (8) Oakley Wood, Vice-President, Barber Steamship Lines, Inc.; Acting Chairman, Committee on Managing Agency Agreement, American Steamship Owners' Association

An American Cargo Carrier of Today. One of the Many Fine Steel Ships of the Modern Merchant Marine. This Vessel Has a Cargo Capacity of 14,000 Tons. She Was Built During the Progress of the Great War

Team Work for the Merchant Marine

"Each for all and all for each" would be an appropriate motto for American shipowners today. Team work is the keynote of their efforts to maintain as a growing and profitable institution the great merchant marine fleet which was created as a result of the war and is being developed and balanced to meet the demands of peaceful world trade. Interchange of ideas, mutual effort for the common good and a closely knit alliance of the various units of the shipping business in matters of policy affecting its general welfare, with means of an interchange of ideas and information with allied interests of national scope, form the basis of new business methods in the American shipping world.

IN the early days of American shipping, now chiefly recalled for the triumphs of our clipper ships, no owner conferred with his competitor on the development of trade routes or the study of economic problems in the shipping business. It was a period of every man for himself among American shipowners, and secrecy was the main stay of each individual's ventures. This was carried so far at one period at the old port of Salem that ships were fitted out by stealth and sailed at night. One Salem ship made three voyages to Sumatra for pepper and earned a fortune for her owner before competitors could discover the source of her cargoes.

Co-operation Necessary

Today such a system is impracticable, nor is it to be desired. The trade map of the world lies before every shipowner, with its every sea route designated. The route on which a ship sails usually is announced in advance. Her freight rate is fixed in competition with other ships of her own and other flags. A ship no longer sails into silence and mystery when she leaves port. She is in daily touch with other ships or the shore by means of the radio. Her consignee or agent in a distant country is advised by cable of her departure and by radio of her progress and expected hour of arrival at her destination, and yet the shipping business is vastly more complex than in the good old days of the sail, when every owner was for himself. Costs are extraordinarily high. Rates in all cases are not adequate to meet those costs, as, for example, in the coastwise trade. The relations of the ship operator and the men employed on his ships are subject to negotiation and agreements into which numerous troublesome ele-

ments enter that were not present in earlier times. Insurance is a complicated and difficult branch of the shipping business; navigation laws, long in need of revision, in many instances are a burden on the shipowner; vast amounts of capital are invested in ships, and to earn adequate returns for these great sums, even with business active, the shipowner must be always on the alert and must know the ebb and flow of trade in all parts of the world.

A community of interests among shipping men therefore is logical and inevitable. By such means the shipping men of the country avail themselves of their combined strength and resources in solving the many problems, economic in the main, that arise in a business so vast as theirs and so newly grown to its present proportions. The country invested between three billion and four billion dollars in ships between 1917 and 1920. This great investment is now subject to the test of competition with the mercantile services of other countries. The task of making the investment permanent rests upon the shoulders of the American shipowners.

American Steamship Owners' Association

Fortunately for the American merchant marine, the shipowners of the country when the war began were not without an organization of a national character, equipped to take the lead in concerted action by shipping interests in behalf of the new-fledged fleet and for the protection of the great investment it represented. This was the American Steamship Association, a body including in its membership the leading companies owning and operating steamships under the American flag. Organized in 1906 by a number of coastwise steamship companies, the association had grown so steadily that in 1917, when the United States entered the world war and embarked upon the great shipbuilding programme that resulted in its present merchant fleet (which by the end of 1921 will embrace 18,000,000 deadweight tons of ocean-going ships), the American Steamship Association included in its membership the principal companies engaged in overseas trade under the American flag. As new companies were formed in the era of rapid shipping expansion that now set in, many obtained membership in the association, which in September, 1919, found an expansion of its organization necessary to carry on its varied and rapidly growing activities. At that time the word "owners" was added to the association's title, and the executive committee, the governing board, was enlarged to twenty-five to make it more thoroughly representative of the increased membership of the association. Mr. H. H. Raymond, president of the Clyde and Mallory Lines, at once a leading figure in the coastwise trade and conspicuous in overseas carrying, who had served as the president of the association for several years, was unanimously re-elected to the presidency. Mr. Edward J. Barber, head of the important Barber Steamship Lines, Inc., operating to the River Plate, the Orient and transatlantic ports, was re-elected vice-president, while Mr. Winthrop L. Marvin was elected to the new office of vice-president and general manager. Mr. Marvin brought to the office a profound knowledge of shipping problems and wide experience in securing coordination of effort by large business interests. At the same time the important office of general counsel of the association was assumed by J. Parker Kirlin, Esq., one of the foremost Admiralty lawyers in the United States.

President Raymond in the strengthened organization has been able to avail himself of the voluntary services of many able men in the shipping business, who, seeing the need of concerted effort by American shipowners, have consented to serve on various committees formed to deal with the vital problems of the merchant marine. Thus in a short time there has been built up an efficient and highly specialized association for dealing with the practical everyday questions of prime importance that confront shipowners and operators in their regular line of affairs.

Association Members Control Large Tonnage

By the spring of 1920 the association's members represented an ownership of not less than 3,000,000 gross tons of steamships under the American flag, or more than three times the amount of the nation's tonnage engaged in overseas trade at the beginning of the war. In addition to this tonnage, the association members operated as agents for the United States Shipping Board between 4,000,000 and 5,000,000 deadweight tons (three deadweight tons about equal two gross tons) of the war-built cargo fleet. The aggregate tonnage thus controlled by the association's members (between 6,000,000 and 7,000,000 gross) was nearly equal the nation's total tonnage, including all ships in the Great Lakes in 1914.

With the Shipping Board the nominal owner of the government-built ships, constant and often exhaustive conferences between the Board and the shipowners and operators are necessary. With legislation before Congress, involving fundamental principles of shipping policy, and therefore the future of the merchant marine as a whole, while the new fleet was not yet completed, it behooved the shipowners to present their views collectively and with unity, clearness and precision.

This has been accomplished through common counsel by the association's

Derby Wharf, Salem, Mass., the Center of American Shipping in 1820

In the First Quarter of the Last Century Salem Was the Foremost American Port for Deep Sea Trade, and in That Period More Rich Foreign Cargoes Were Landed at This Old Wharf Than Anywhere Else in the United States. From a Photograph in the Peabody Museum, Salem, Taken About Forty Years Ago

members and by sustained and intensive work by its committees. A brief summary of the functions of a few of these committees will serve to indicate the practical character of the work handled by the association.

An American Cargo Carrier of a Century Ago

Vessels of This Type Laid the Foundation of Our Merchant Marine and Won Fortunes for Their Owners. This Ship, the *Erin*, Registered 270 Tons. From a Painting by Montardier, a French Artist, Made in 1819.

Committee on Managing Agency Agreement

The duty of this committee is to deal with matters pertaining to the agreement with the United States Shipping Board, under which members of the association operate government-owned ships. Members of the committee attend fortnightly conferences at Washington of a joint committee composed of representatives of the Shipping Board, the shipowners of the Atlantic, Gulf and Pacific coasts, and the United States Ship Operators' Association. These conferences deal with affairs involving a greater volume of shipping traffic in one month than half a century ago stood to the credit of the entire American merchant marine in a year. Mr. Franklin D. Mooney, president of the New York and Porto Rico Steamship Company was appointed first chairman of this committee on behalf of the American Steamship Owners' Association. During Mr. Mooney's absence on a trip abroad, Mr. Oakley Wood, vice-president of the Barber Steamship Lines, Inc., served as acting chairman.

Committee on Wages and Working Conditions Aboard Ship

The negotiation annually of a working agreement with representatives of the sea-going unions on wages and working conditions (in conjunction with the United States Shipping Board) and the adjustment of all differences between the labor aboard their ships and the members of the association, are the principal duties of this committee, whose findings are the basis of present wage agreements on all American ships plying out of Atlantic and Gulf ports. Captain Eugene E. O'Donnell, manager marine department, C. H. Sprague & Son, Boston, is chairman of this committee. The names of the other members indicate the representative character of the committee:

Captain William Anderson, manager marine department, C. H. Sprague & Son, Boston, Mass.

A. G. Bates, vice-president, Atlantic & Pacific Steamship Company (W. R. Grace & Company).

Captain John G. Crowley, president, Coastwise Transportation Company.

J. D. Tomlinson, operating manager, American Hawaiian Steamship Company.

A. S. Hebble, superintending engineer, Southern Pacific Company.

E. A. Kelly, assistant to president, Clyde Steamship Company.

R. C. Thackara, vice-president, Luckenbach Steamship Company, Inc.

A. J. McCarthy, manager, American flag steamers, International Mercantile Marine Company.

F. C. Osborn, manager ownership operations department, Munson Steamship Line.

Robert F. Hand, assistant manager foreign shipping department, Standard Oil Company of New Jersey.

Committee on Depreciation

The question of the proper depreciation to be charged off annually on account of vessels owned for purposes of taxation and otherwise has been one of the most vexing to come before the members of the association. This committee sent out a questionnaire to American shipowners, seeking their views on the subject, and embodied the replies received in a report to be submitted to the association and by it to the Shipping Board and to the Treasury Department. The chairman of this committee is Mr. Alfred Gilbert Smith, president, the New York and Cuba Mail Steamship Company.

Another active committee of the association deals with the subject of the revision of the United States navigation laws and rules, including the laws and rules of the Steamboat Inspection Service, which is now being considered also by a special commission appointed by the Shipping Board. Still another committee of the association is that which deals with accounts and auditing, with especial regard to the accounts of government-owned vessels operated by the shipowners. This committee is composed of auditors of the member companies of the association.

Its own solidarity assured, the association has established close relations with other shipping associations in the country. These include the following:

United States Ship Operators' Association, New York.
Pacific American Steamship Association, San Francisco.
Puget Sound Shipowners' Association, Seattle.
New Orleans Shipowners' Association.
New York Boat Owners' Association, New York.
Lake Carriers' Association, Cleveland.
National Board of Steam Navigation, New York.

Other business associations with which the American Steamship Owners' Association is in close touch include the following:

American Manufacturers' Export Association, New York.
National Foreign Trade Council, New York.
National Association of Manufacturers, New York.
Atlantic Coast Shipbuilders' Association, New York.

Through the United States Chamber of Commerce the association is enabled to present data concerning the economic phases of the shipping business to business men in

all sections of the country. Illustrating this connection, it may be stated that after members of the association had appeared before the Senate committee on commerce at hearings on the measure later known as the Jones bill, their arguments, printed in pamphlet form, were distributed to the chambers of commerce of the country through the co-operation of the United States Chamber of Commerce. Information on the merchant marine and overseas trade is supplied this national body of business men by the association whenever it is requested.

Touch with the banking interests of the country has been maintained by the association through an interchange of views and information with the committee on ship securities, appointed by the United States Shipping Board from among prominent bankers, with Henry M. Robinson, of Pasadena, Cal., as chairman. This committee has made a study of the relation of present shipping values, costs and earnings to popular investment in shipping securities and has submitted its first report to the Board.

Other organizations with which the association maintains relations are:

National Marine League of the United States of America, New York.
National Merchant Marine Association, Washington.
Navy League of the United States, Washington.

These three organizations disseminate information about the merchant marine through the press and by means of speakers, while the National Marine League is sponsor for the National Marine Exposition, which was held for the first time in April, 1920, at New York, and which will become an annual event in the marine calendar.

To each of the organizations named, the association sends its published communications, and in many cases special bulletins on matters regarding the merchant marine that are of current interest to business men. Furthermore, it has adopted a policy, now in effect, of supplying information of public interest on shipping matters to the daily and trade press whenever it is requested. With the growth of our merchant marine, there has developed a widespread interest in ocean trade and commerce, and the American Steamship Owners' Association has come to be accepted as, in a sense, a clearing house of information on matters maritime all over the United States.

Bulkheads

BY C. H. PEABODY, DR. ENG.

It is not commonly known that the United States has no adequate legal provision against overloading of ships whether in foreign or domestic commerce. At this time, when our merchant marine is holding a leading position in public interest, it is important that the present status of this question of safety at sea should be clearly in mind.

IN January of 1914 the International Convention on Safety of Ships at Sea made its first report. This statement is proper, even though the convention adjourned sine die, because the reports were so broadly worded that some subsequent convention was evidently needed and anticipated. The convention wisely determined only the main guiding principles, leaving the details to be worked out in the future.

The nations represented in the convention were Germany, Austria, Belgium, Denmark, Spain, United States, France, Great Britain, Italy, Norway, Holland and Russia.

The various subjects considered by the convention were navigation, construction, radio telegraphy, life-saving appliances and fire protection. The subject now selected for consideration is that of bulkheads, the proper number, their location and construction and provision of strength. Even so restricted, the subject can be treated only in a general manner.

Subsequent to the report of the convention, the British Board of Trade appointed a committee on bulkheads and watertight compartments, which reported in November, 1914. This report presents valuable constructive work in interpreting the general recommendations of the convention and in providing methods for applying them.

In September, 1916, the Honorable W. C. Redfield, then Secretary of Commerce, called a conference at Washington of shipowners, shipbuilders and naval architects, to consider establishing load lines on vessels enrolled in the United States, with which the matter of bulkheads and subdivision is intimately connected. A committee was appointed to consider and report on the establishing of load lines. That committee made a report in December of that year. In consequence of the entrance of the United States into the World War the matter of load lines passed into abeyance, but was revived in October, 1919, and is now under consideration. Subcommittees have been appointed for the Atlantic coast, for the Pacific coast and for the Great Lakes, and reports may be expected in the near future.

In this article we shall refer mainly to the report of the British committee on bulkheads; for brevity, we will call them the *committee*. Some reference will be made to the report of the British committee on vessels navigating local waters; we will call them the *local committee*.

Having in mind that steel steamers usually have the machinery amidships, we remember that they have at least four bulkheads, one forward and one aft of the machinery space, and also forward and aft peak bulkheads. Ships with the machinery right aft may have three bulkheads. The peak bulkheads may limit the influx of water due to injuries near the stem or the sternpost and thus save the ship from disaster. But the bulkheads forward and aft of the machinery space (when there are only three or four) are for convenience of service, and the ship will be lost if either the forward or aft holds are flooded. The exception to this statement occurs when the holds are full of cargo lighter than water, like lumber or cotton. Small vessels must put up with these conditions because the holds cannot be subdivided without too serious interference with service. There is no use in subdividing a ship for safety, if it is consequently put out of service. As ships become larger, and especially longer, the subdivision of the holds may proceed without undue interference with the service. The transatlantic passenger ships were so subdivided that their safety after collision (should that occur) was considered sufficient; but the loss

of the *Titanic* showed that this confidence was misplaced. It was after this disaster that the international convention was called.

Results of the Convention

The convention expressed the result of their labors in connection with the determination of the proper load line for a ship and (concomitantly in connection with the discussion of bulkheads and subdivision) in the terms of *floodable length*. Speaking in general terms, the floodable length is the length between bulkheads that can be allowed without too much danger of the immediate loss of the ship should the compartment be filled with water by collision or otherwise. But before giving the formal definition of floodable length, the convention determined a *margin line*. This line is defined as being located three inches below the *bulkhead deck*. The *bulkhead deck* (if continuous) is the deck to which all bulkheads subdividing the holds are to be carried. Discontinuous bulkhead decks will be considered later.

Now the convention found it necessary to compromise between the desire to prescribe sufficient subdivision of the hull to ensure safety after collision and the necessity of avoiding undue interference with the service of the ship. This compromise is made by a factor for subdivision. This factor varies from unity to 0.34, depending on the length of the ship. The factor unity leads to the condition that *one* compartment may be flooded without losing the ship; the factor 0.05 gives a like condition when two adjacent compartments are flooded; the factor 0.34 appears to fall short of providing that three compartments may be flooded. But other conditions ameliorate this requirement so that 0.34 yields immunity when three adjacent compartments are flooded. The convention gave the following table:

Factor of Subdivision	Length of Freight and Passenger Vessel (Feet)	Length of Passenger Vessel (Feet)
1.00	295	259
0.90	374	285
0.84	404	305
0.65	489	380
0.50	571	489
0.39	699	685
0.34	899	899

This table shows that ships 259 feet long are one-compartment ships, in that only one compartment may be flooded without immediate danger. Ships 489 feet long are two-compartment ships, and only ships 900 feet long arrive at the dignity of three compartments.

Permeability

The amount of water that can enter a flooded compartment is limited by the material already there. This is defined by the *permeability*, which is the ratio of the water entering to the empty space. There are three degrees of permeability named by the convention:

(1) *Sixty percent* in cargo spaces, bunkers, baggage rooms, etc.
(2) *Eighty-five percent* in machinery spaces, including boiler rooms.
(3) *Ninety-five percent* in passenger and crew spaces, peaks, double bottoms, etc.

Floodable Length

We may now define the *floodable length* at any point along the hull as the percentage of the length of the ship that can be flooded without bringing the ship below the margin line, taking account of permeability and the factor for subdivision.

Let us try to visualize what this provision means. Suppose that the fore hold is 200 feet long and that the floodable length as computed is 70 feet, then there clearly must be two bulkheads in the hold between the boiler room bulkhead and the fore peak bulkhead; they need not be equally spaced provided no compartment is more than 70 feet long. Finally, it is specified that no compartment shall be more than 92 feet long. Again, the length of the forepeak tank is required to be at least 0.05 of the length of the ship. Ships which have a greater degree of security than required by the convention are to have that fact entered on their Safety Certificate. In a general way, we may conclude that all passenger ships will have one or two bulkheads in each of the fore and aft holds; long ships will have a larger number.

Floodable Length Diagrams

The greatest constructive work of the committee appointed by the Board of Trade is presented in the form of diagrams for determining the floodable length of a ship conformable to the requirements of the convention. These curves enable a designer to determine this condition during the preliminary design.

The committee advises that the determination of floodable length by aid of the diagrams be accepted without reservation and that subsequent computations after the design is completed need not be made. Anyone familiar with the labor and uncertainty of such calculations can understand the importance of this work of the committee. There are twenty-three plates of floodable length diagrams, twelve for a permeability of 60 percent and eleven for 100 percent; percentages between 60 and 100 require interpolation, but since such interpolations are for 80 percent or more the interpolation is quite satisfactory. The floodability diagrams vary with (1) the freeboard ratio, (2) the block coefficient, (3) the ratio of freeboard to draft, and (4) the sheer. It has been found in practice that the diagrams can be used without undue difficulty.

The report of the committee gives also diagrams for determining coefficients of water plane area, moments of inertia and centers of flotation; also curves of sectional areas for standard forms. Thus the designer has the means of investigating the initial stability of his ship while the preliminary design is under way.

Modification for Varying Types

When the subject of freeboard and subdivision of the hold has been settled for ships with a continuous bulkhead deck the trouble has just begun, because ships which are for all sorts of purposes and designed to avoid excessive port dues in various services take a multiplicity of forms, such as well decked ships, ships with raised forecastles and ships with long poops extending even to the bridge; also shelter deck ships and ships with long bridge houses amidships. All these matters, and also the effects of continuing certain bulkheads to a deck higher than the bulkhead deck are considered by the committee. They also have recommendations for ships that vary their passenger accommodation by interchanging certain spaces between passengers and freight. A very sensible suggestion for such ships is that they shall have two load lines, especially if they habitually carry more passengers one way than the other.

The committee further gives consideration to the fitting of longitudinal bulkheads, especially in the form of side bunkers, and suggests that allowance be given for suitable use of such means of limiting flooding of the hold. But the committee merely calls attention to the danger of a list due to flooding a side compartment either from

loss of stability or from interference with lowering boats. In the same place the committee deals with the desirability of fitting inner skins along the side of the ship. Many other items are considered by the committee which cannot even be mentioned without leading to confusion or else to undue prolixity.

The convention considered the matter of doors in bulkheads and means of controlling them, and here again the committee offers practical suggestions looking toward guarding the integrity of the compartments without interfering with necessary access to them.

It may not be too strong a statement to say that no working ship can be made unsinkable; the only exception is the lumber schooner with the hold full and the deck load washed overboard.

Strength of Bulkheads

Any regulation for subdivision must be a compromise. But there is another aspect of the bulkhead question where compromise should not be tolerated, and that is the matter of strength. Only too many reports of collision give sensational accounts of the heroic efforts of the ships' officers to stay bulkheads that begin to yield under excessive pressure. There is no discount on the heroism, but what shall be said of the shipbuilder who puts in a bulkhead too flexible to stand up under service?

Now the computation for a bulkhead frame or stiffener is a straightforward problem for the constructor. It may have its uncertainties due mainly to the difficulty of properly securing the ends, but they can be met either by looking after fastenings or by reasonable allowances in computation. It is not too much to say that a bulkhead with frames intelligently designed will not fail; the failure is due to insufficient stiffeners ill-secured at the ends. An insufficient bulkhead will pull loose at the rivets around the edge and either fail altogether or leak so fast that the next compartment is soon flooded. Not a little of the fault lies in the use of the term "stiffener," which carries the assumption that the plating is the bulkhead and that undue bulging can be reduced by riveting stiffeners to the plating. It should not be necessary at this time to insist that the framing of the bulkhead must carry the load and the plating is riveted to the framing to stop the flow of water. Indeed, if the framing is insufficient the plating may bulge if it wants to; it cannot get away and will only leak a little.

Now the real trouble about bulkheads is that except in tankers and similar ships no bulkhead is tested in regular service as is the frame and plating of the ship. A ship being a riveted structure is likely to give signs of weakness long before it will fail; there may be a chance for strengthening the ship, and at any rate future ships may take warning. But any bulkhead appears to be sufficient until it is tested, and testing bulkheads (except in tankers) is practically impossible, either under construction or in service. A ship is likely to be strained when a large compartment is filled, say nothing about interference with service. In 1898 a bulkhead in the U. S. S. *Illinois* was tested by Naval Constructor J. J. Woodward and reported to the American Society of Naval Architects and Marine Engineers while on the building slip. The writer is not aware that so complete a test has been made since in the United States.

The Board of Trade Committee procured the construction of a steel cofferdam simulating the conditions of a bulkhead and with methods of construction habitual for ship work. Various forms of stiffeners were used such as angles, bulb angles, channel bars and double flange plate stiffeners. Proper attention was given to securing the ends. The committee properly requires that every stiffener shall be able to carry its load without undue deflection and shall not depend on any assistance from the diaphragm action of the plate.

Tables of scantling for stiffeners with 30-inch spacing are given by the committee, based on computations and checked by comparison with experiments on the cofferdam.

Coastwise Vessels

The local committee has made a brief report giving recommendations for reasonable provision for safety of ships in the local sea service in the British Empire. Such vessels are usually small and the conditions that can be imposed without interfering unduly with service are few and simple.

Mention has been made of the committee appointed by the Secretary of Commerce to deal with bulkheads and subdivision of the hold, and of the subcommittees for the Atlantic coast, the Pacific coast and the Great Lakes. We can await the results of their deliberations with confidence. It, however, may not be out of order to point out the difficulty of their tasks, which are indeed different, but with certain elements of similarity.

In a recent number of this publication is the description of a new passenger ship for service on the Pacific coast, and not under the jurisdiction of the United States. It has all the characteristics of the passenger and freight steamer of the American type. It is about 250 feet long, has a draft of 13 feet and the bulkhead deck is 3 feet above the load waterline. It has bulkheads forward and aft of the machinery space and the usual forward and aft peak construction. The two holds and the machinery space are undivided. The ship has a deck 10 feet 6 inches above the waterline, but the space under this deck is used mainly, if not exclusively, for passengers and is practically open fore and aft for the length of the ship. The ship is fitted for 330 passengers and has a crew of 56 men. Intact such a ship is able to make fairly long voyages safely in the open sea. As for subdivision it has none. It is shown as fitted with six lifeboats that can carry 150 persons. A superficial examination of the plans leads to the conclusion that the designer has probably done all that he could. The provision for saving life appears to be an effective coast guard.

Naval Architects' Meeting

The twenty-eighth general meeting of the Society of Naval Architects and Marine Engineers will be held on November 11 and 12 in the Engineering Societies Building, 29 West 39th Street, New York. The annual banquet will be held in the Waldorf-Astoria Hotel on Friday evening, November 12.

Shipments to the Philippine Islands.—G. W. Cruickshank, Zamboanga, P. I., who is in the market for steam specialties, writes to Marine Engineering that it is very hard to obtain machinery or supplies from manufacturers in the United States for the reason that the majority of them seem to think they are corresponding with their next door neighbor. Although they send descriptions of their products, they do not quote prices, necessitating six months' delay before an order can be placed, which means nine months before the goods can be delivered. Our correspondent believes that the export trade to the Philippines is going to be of considerable importance in the near future, and American manufacturers should wake up to this opportunity.

Relation of Beam to Height of Metacenter

BY F. M. HIATT

Naval architects ordinarily consider the metacentric height of a vessel (i. e., the distance between the center of gravity and the transverse metacenter) as one of the principal factors governing the behavior of a vessel at sea. In the early stages of design the height of the center of gravity is estimated and to determine a satisfactory design with respect to sea behavior a suitable metacentric height is chosen. Together these fix the height of metacenter above base desirable for the case in hand. For any given design beam is the principal dimension which most affects the height of metacenter, but other factors enter into the problem to a greater or lesser extent. The water plane coefficient and the shape of water plane, the form and fullness of the underbody, the size of the vessel and the ratio of beam to draft all have their effects.

THE purpose of this paper is to present the derivation of certain curves which enable one, in the first stages of design, to determine quickly the height of metacenter above the base, which will result from any desired combination of dimensions and form-coefficients.

The curves here presented are based upon Normand's formula for height of the center of buoyancy and the ordinary expression $BM = \frac{I}{V}$. The latter of these two formulae is mathematically accurate. The former probably needs no defense, but it may be well in passing to state that a study of some fifty or more ships indicates for it a very close degree of accuracy. Ships of all types and sizes were included in a comparison between the height of the center of buoyancy by Normand and by detailed calculation. In most cases the error by formula was found to be less than one-tenth of a foot, but in a few cases it was as high as two-tenths. In one case an error of nearly five-tenths was noted, but in fairness to the formula it must be stated that the information for this ship was of doubtful reliability, and the case is here noted to indicate a possibility rather than a probability of error in cases of eccentric design. The study indicates that curves based upon these two formulae will, in practically all cases be accurate within one-half of one percent.

Derivation of Curves

In the following derivation the base line is taken at the under side of the flat plate keel.

L = length of load waterline in feet.
B = beam on load waterline amidship in feet.
H = mean draft in feet to load waterline (measured from base line).
M = height of metacenter above base in feet.
l = longitudinal or prismatic coefficient.
m = midship section coefficient $= \frac{\text{area of midship section}}{BH}$.
b = block coefficient.
p = waterplane coefficient $= \frac{W}{LB}$.
v = vertical prismatic coefficient $= \frac{lm}{p}$.
I = moment of inertia of load waterline in square feet $\times$ feet^2.
W = area load waterline, square feet.
V = volume of displacement, cubic feet.
ρ = radius of gyration of load waterline in feet.
K = a factor hereafter described as the inertia factor of load waterline.
CB = height of center of buoyancy above base in feet.
BM = distance from center of buoyancy to M in feet..

Normand's formula may be put in the form

$$CB = H - \tfrac{1}{3}\left(\frac{H}{2} + \frac{V}{W}\right) \qquad (1)$$

and

$$BM = \frac{I}{V} \qquad (2)$$

then

$$M = \frac{I}{V} + H - \tfrac{1}{3}\left(\frac{H}{2} + \frac{V}{W}\right) \qquad (3)$$

but

$$V = lmLBH$$
$$W = pLB$$

and

$$I = \rho^2 W = \rho^2 pLB$$

whence by substitution and rearrangement (3) becomes

$$M = \frac{\rho^2 p}{lmH} + \tfrac{5}{6}H - \frac{lm}{3p}H \qquad (4)$$

Now the radius of gyration ρ is a linear quantity and we may let

$$\rho = \sqrt{K}B \qquad (5)$$

in which K is a constant for any given water plane and K remains the same for that water plane for all beams or lengths to which it may be expanded. It is especially to be noted that we may expand a plane by one ratio for beam and by another ratio for length without change in the inertia constant K.

Substituting this value for ρ in equation (5) we get

$$M = \frac{Kp}{lm}\frac{B^2}{H} + \tfrac{5}{6}H - \frac{lm}{3p}H \qquad (6)$$

and remembering that $\frac{lm}{p} = v$, this may be written

$$M = \frac{K}{v}\frac{B^2}{H} + \left(\tfrac{5}{6} - \frac{v}{3}\right)H \qquad (7)$$

This is the equation upon which the curves here presented are based. K is the inertia parameter. Its absolute value is dependent upon the shape of the water plane to be used, and the same will be discussed presently and a chart presented, enabling one to choose readily a value appropriate for any given case. v is a parameter dependent upon the underwater form of the vessel. Since l, m and p are chosen in the very early stages of design, a simple slide rule operation quickly determines the proper value of v.

With K and v fixed, let us assume some value for M. Since K and v are always positive and v is never greater than 1, the resulting curve is an ellipse in B and H. We may call this an iso-M ellipse. Plate I shows such an

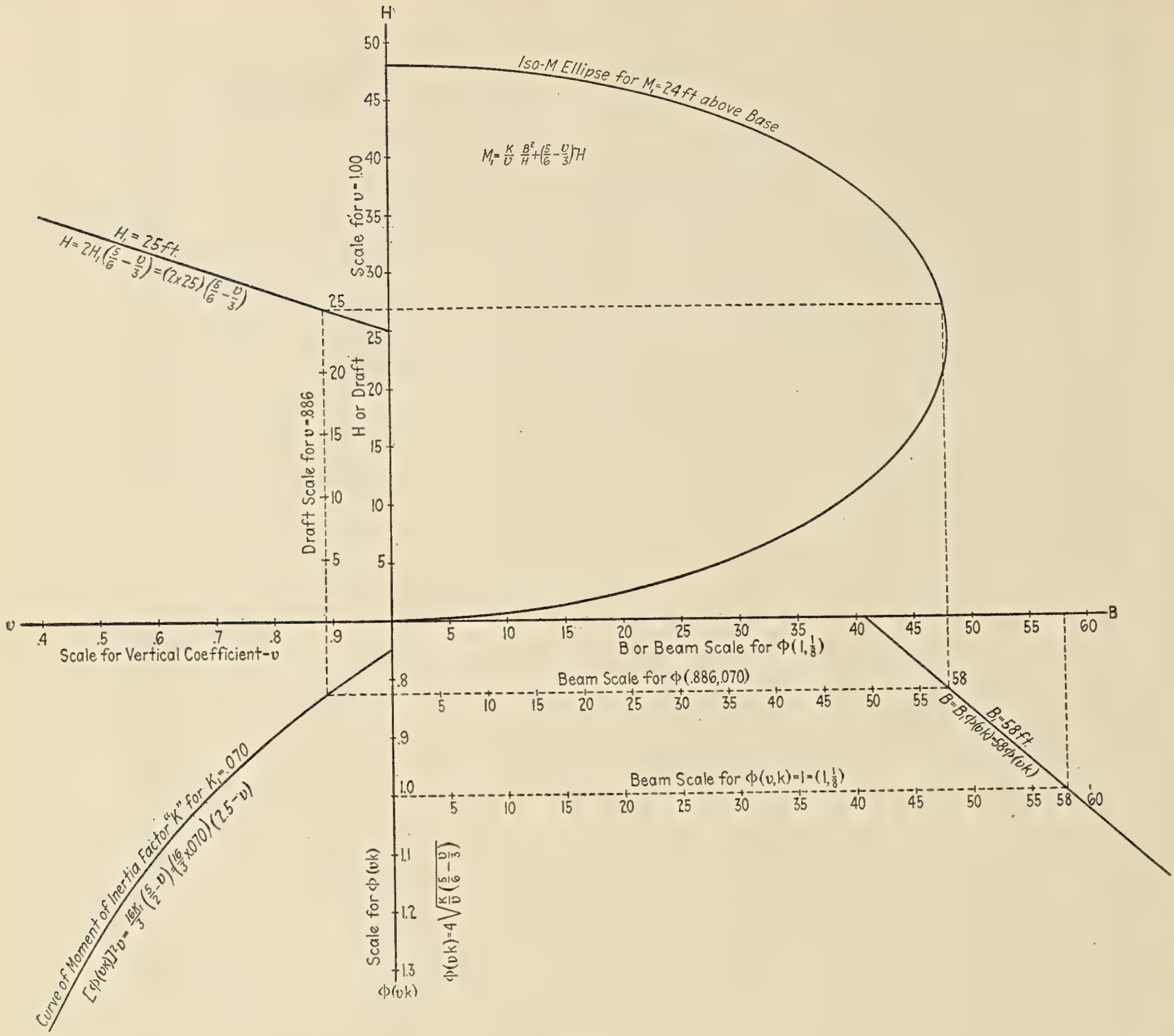

Plate I

ellipse. For that ellipse v was taken equal to 1, K equal to $\frac{1}{8}$, and M was assumed equalling 24. Obviously other ellipses for other values of M, but for the same values of v and K, could be plotted on the same sheet and referred to the same axes. Such a sheet would solve equation (7) for all heights of metacenter provided v equalled 1 and K equalled $\frac{1}{8}$, but, as it happens, in practice v rarely equals 1 and K never equals $\frac{1}{8}$. It does happen, however, that these assumed values result in ellipses of suitable character for our use and, properly treated, such a series may be made to solve our equation for any and all values of v and K.

Mathematical analysis develops the facts that the H axis of any iso-M ellipse equals

$$\frac{M}{\left(\frac{5}{6} - \frac{v}{3}\right)}$$

and the B axis equals

$$\frac{M}{\sqrt{\frac{K}{v}\left(\frac{5}{6} - \frac{v}{3}\right)}}.$$

There are three facts to be noted in connection with the axes of these ellipses: (a) Division between the axes results in an expression in v and K with M eliminated; (b) the H axis is a function of M and v only; (c) the B axis is a function of M, v and K.

Returning to Plate I, since (a) is true, for $M = 24$, we can use the ellipse there plotted to solve equation (7) for any values of v and K, provided we append new and proper scales for H and B. Since (b) is true, the H scale will be a function of v and M, and since we intend to use this ellipse for only one value of $M = 24$ and will add other ellipses for other values of M, we may say the H scale is a function of v and a constant. Finally, since (c) is true, the B scale must be a function of K, v and M, which may be taken as K, v and a constant.

The ellipse in the figure might have been plotted for any value of M. To make the case general, let us assume that M equals any fixed value M_1. Remembering that $v = 1$, the H axis equals $2M_1$, let us assume that this axis is measured in units H_1. In general, for other values of v and for $M = M_1$, the H axis equals

$$\frac{M_1}{\left(\frac{5}{6} - \frac{v}{3}\right)}.$$

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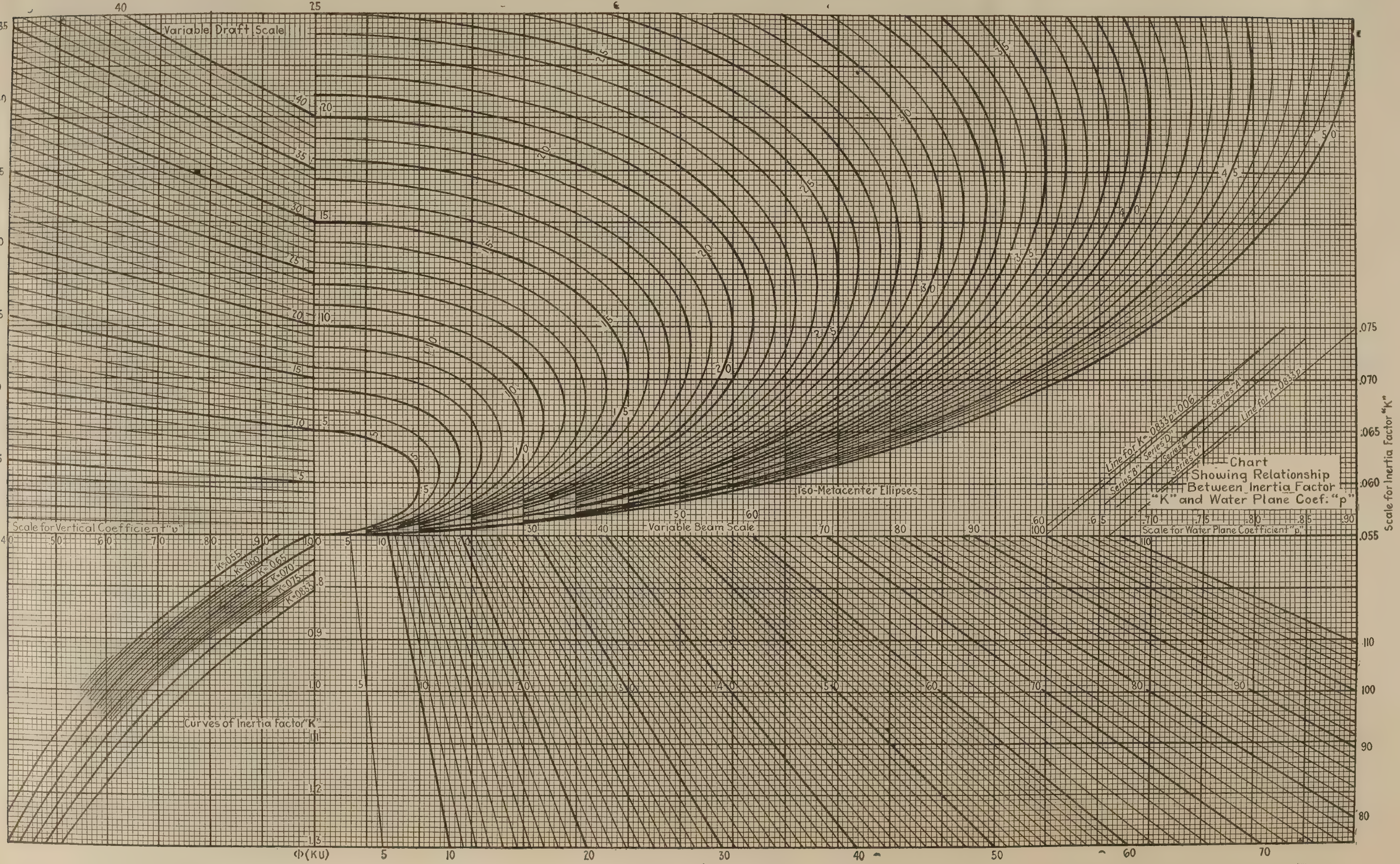
4

RELATION OF BEAM TO HEIGHT OF METACENTER



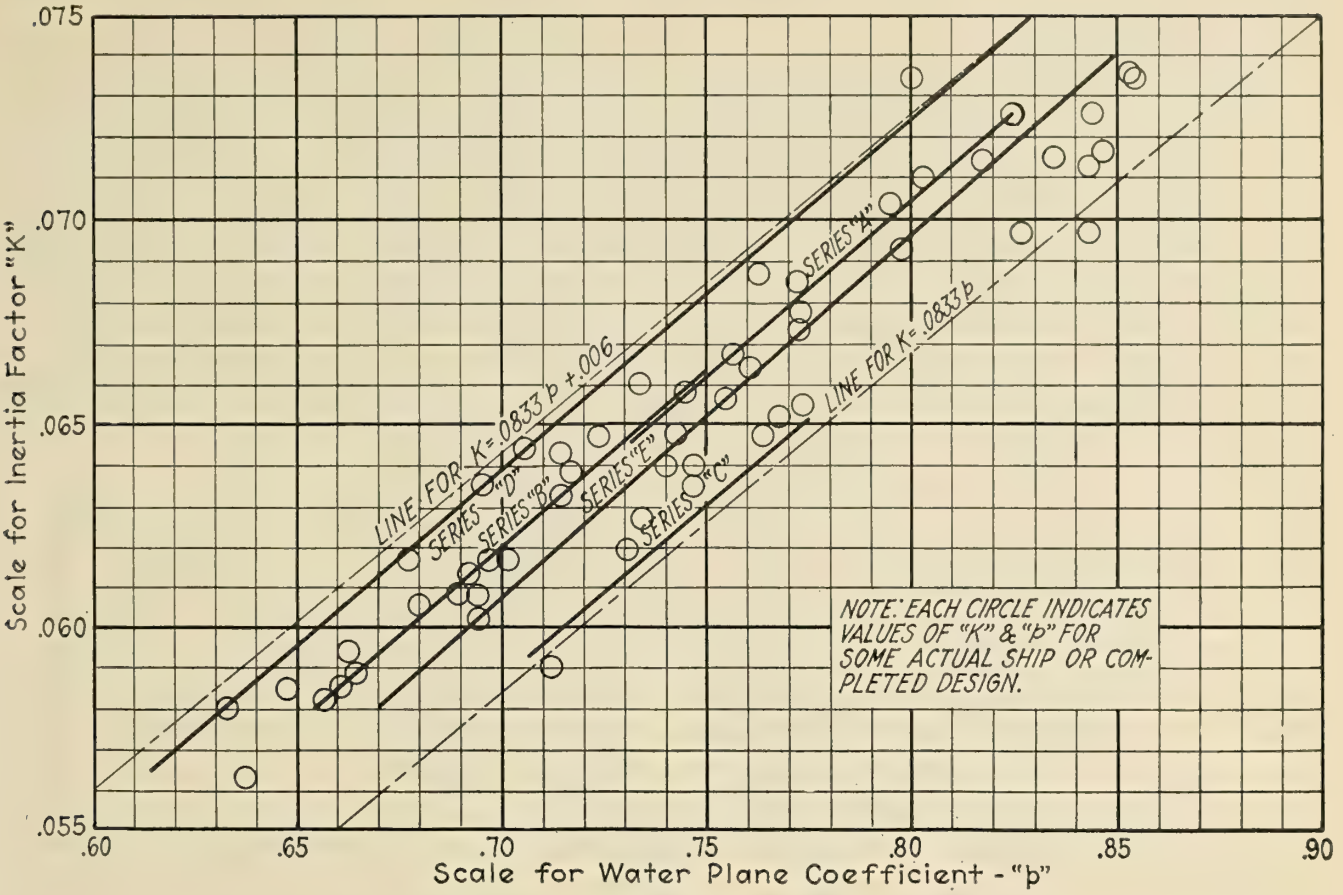


Plate III

In the general case let the H axis be measured by the variable unit H. Now since we desire to use this same ellipse for all values of v, we may say

$$\frac{M_1}{\left(\frac{5}{6}-\frac{v}{3}\right)} H = 2 M_1 H_1 \qquad (8)$$

and considering v and H as our variables, we have an equation for our variable H scale. From this expression M_1 eliminates upon simplification and (8) may be written

$$H = 2\left(\frac{5}{6}-\frac{v}{3}\right) H_1 \qquad (9)$$

This is the equation of a straight line. By substituting successive values for H_1, the corresponding successive markings of our draft scale may be determined. The upper left-hand quadrant of Plate I shows a draft line for a value of 25 feet. It will be noted that the v axis is taken coincident with the B axis, but the origin for the draft line in H and v is to the left of the origin for the ellipse in H and B.

Turn now to the variable scale for B. The ellipse being plotted for $v = 1$ and $K = \frac{1}{8}$, the B axis of the ellipse equals $4M_1$, but in general the B axis of an iso-M ellipse equals

$$\frac{M_1}{\sqrt{\frac{K}{v}\left(\frac{5}{6}-\frac{v}{3}\right)}}$$

Let the first be expressed in fixed units B_1 and the second in variable units B. Then

$$\frac{M_1}{\sqrt{\frac{K}{v}\left(\frac{5}{6}-\frac{v}{3}\right)}} B = 4 M_1 B_1 \qquad (10)$$

which is our equation in B, v and K for our beam scale. Simplified, (10) becomes

$$B = 4\sqrt{\frac{K}{v}\left(\frac{5}{6}-\frac{v}{3}\right)} B_1 \qquad (11)$$

Since we are working in two dimensions only, we cannot plot equation (11) directly, because it contains three variables v, K and B. To eliminate one variable, let

$$4\sqrt{\frac{K}{v}\left(\frac{5}{6}-\frac{v}{3}\right)} = \phi\ (vK) \qquad (12)$$

and equation (11) may then be written

$$B = B_1\ \phi\ (vK) \qquad (13)$$

In Plate I it will be noted that a suitable scale for $\phi\ (vK)$ has been marked, the $\phi\ (vK)$ axis being coincident with the H axis, but with the origin above the origin for the ellipse. Equation (13) is a straight line in B and $\phi\ (vK)$. Substituting successive values for B_1 will produce the successive markings for our variable B scale. A beam line for $B = 58$ is shown in the plate.

We must now provide a means for evaluating $\phi\ (vK)$. Fortunately we have remaining one unused quadrant with one axis already laid off with a suitable v scale, while the other is marked with a scale for $\phi\ (vK)$. As marked, the origin between these scales is above the horizontal and to the left of the vertical axis. Equation (12) may be written in the form

$$[\phi\ (vK)]^2\, v = \frac{16K}{3}\left(\frac{5}{2} - v\right) \qquad (14)$$

from which it appears that in general the curve is a modified form of the Witch of Agnesi. If K equals 75/64, the curve becomes a true Witch, the generating radius of which is 1.25. Let us assign successive values to K and

plot the resulting curves in v and ϕ (vK). On Plate I one such curve is shown for a value of $K = .07$.

We now have one ellipse for $M = 24$, one draft scale mark for $H = 25$, one beam mark for $B = 58$, and one K curve for $K = .07$. The dotted lines indicate the solution of equation (7) for a value of $v = .886$. To be able to solve the equation for general cases, ellipses for other values of M must be added, likewise draft and beam scales must be completed and we must add curves for other values of K. Plate II has accordingly been prepared. By means of this plate the general equation may be solved for any values of v, K, M, B and H commonly met with in practice. The method is in general the same as that indicated in the preceding plate.

As noted earlier in the discussion, v is readily calculated by slide rule $\left(v = \dfrac{lm}{p}\right)$, but if the curves are to be of material benefit, we must know what value of K may be suitable for any given design in hand.

It is at once apparent that K may be varied either by a change in water plane coefficient or by altering the shape of the plane, either with or without a change in p. Actual values of K for a number of water planes have been computed and the results of this study are indicated on Plate III. Each circle indicates the value of K for some actual ship. This study covered ships of all types and sizes and indicates that in the zone of good practice K has a value lying between $.0833p$ and $.0833p + .006$. It is possible that extreme types may be encountered with values outside these limits.

In general, pronounced shoulders and fine ends tend toward high values of K for a given water plane coefficient, while fining of the plane amidships with a filling out at the ends, as in cruiser sterns or broad stern speed boats, lowers the value of K. For the purpose of visualizing the relation between K and the water plane shape, Plate IV has been prepared. Figs. 1, 2 and 3 thereon show certain standard series of water planes. These series were prepared by Mr. J. L. Bates, and thanks are due to the *Shipbuilding Cyclopedia* for permission to reproduce them here. Figs. 4 and 5 have been added to illustrate other variations in water planes. Curves of K on a p base for all of these series have been plotted in Plate III. It is believed that a passing study of these plates will enable one to choose a suitable value of K from the insert in the upper right-hand quadrant of the plate of curves. In case one has certain water planes for standard use, it might be found worth while to compute values of K for such planes and mark them in the figure.

In the quadrant of Plate II, where the K curves are plotted, it will be noted that intermediate values of K to the nearest .001 are shown over a limited space only. It will be found that this is the area of good practice and that values much outside of this area are indicative of eccentric design.

As an illustration of the use of the curves, assume that we have in hand the design of a ship of 17,000 tons displacement on a draft limited to 28 feet. It is proposed to use a midship section coefficient of .96, a prismatic of .77, and a water plane in general similarity to the type of plane shown in Series *A*, Fig. 1 of Plate IV. The water plane coefficient chosen is .82. For this ship a height of M above base of 25 feet is desired.

$v = .901$.

Referring to the insert on Plate II, for the type of plane selected (Series *A*) a value of $K = .072$ is indicated as corresponding to $p = .82$.

Enter the plate of curves on the horizontal axis at $v = .901$ and lay a ruler or a strip of paper perpendicular to the horizontal axis. This marks at once the proper H or draft scale to use. The proper B or beam scale is found running horizontally from the intersection of the curve for $K = .072$ with the line of the H scale produced. On the ellipse for $M = 25$ we find that for a draft of 28 feet a beam of 59.5 feet will be required to obtain the desired height of M. This draft and beam with the coefficients used calls for a length on the load waterline of 483 feet to give the required displacement of 17,000 tons. If this length meets the needs of the case, the problem is solved. If the length is not suitable, we of course have the usual options in compromising between conflicting interests. However we may desire to effect this compromise, the curves will readily solve the equation in accordance with any assumptions made.

This paper would perhaps be incomplete without mention of other possibilities in the way of plotting. Th equation here treated as an iso-M ellipse in H and B might have been considered as an iso-B hyperbola in H and M or an iso-H parabola in M and B. The possibilities of the hyperbola and the parabola were investigated in some detail, but for a general set of curves of universal applicability the ellipse seemed best to fill the needs of the situation and for that reason was here chosen. The H parabola was apparently inferior in all respects to either of the other curves.

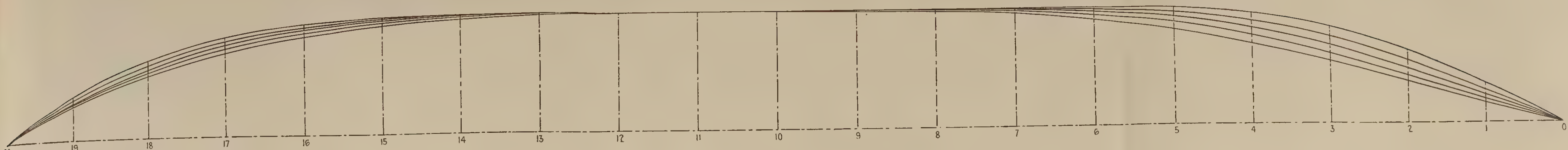
If, however, standard waterlines are established, and especially if these are associated with standard sectional area curves, the hyperbola in H and M possesses some advantages. Reference has heretofore been made to certain standard water planes established by Mr. J. L. Bates and appearing in the *Shipbuilding Cyclopedia.* These water planes are associated with certain sectional area curves, so that when one chooses a longitudinal coefficient suitable for any design, the sectional area curve is thereby determined; and associated with that sectional area curve is a suitable water plane. Thus l, p and K are determined by once choice of l. To evaluate the expressions $\dfrac{Kp}{lm}$ and $\dfrac{lm}{3p}$ appearing in equation (6), a choice of midship section coefficient m is then necessary. A series of sheets of iso-B hyperbolas is then submitted for various values of m, and interpolation may be resorted to for values of m lying between two sheets.

One advantage of these standard curves which seems immediately apparent lies in the fact that the water planes have been so chosen and have been related to the standard sectional area curves in such a manner that one may alter the longitudinal coefficient at will without changing the height of M, the effect of the change in l being counterbalanced by an automatic change in the water plane. This in effect reduces the number of variables entering into the problem of preliminary design and thus reduces its complexity.

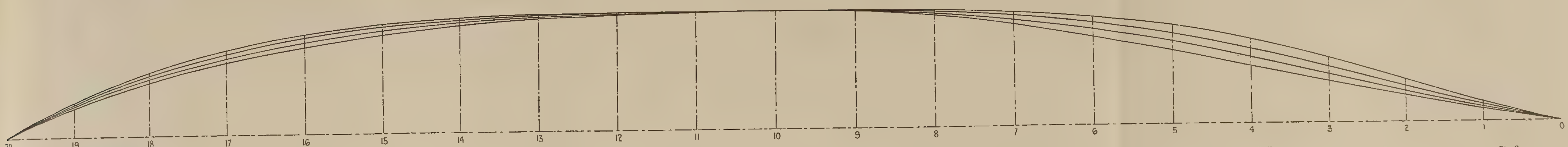
On the other hand, one advantage of the curves here presented lies in the fact that they are not associated with any standards but are applicable to any and all ships alike. Anyone desiring to establish standard planes may readily compute values of K for such a series and thus make his reading of the plate somewhat more accurate. It is believed, however, that for ordinary purposes of preliminary design this will not be found necessary.

INTERNATI

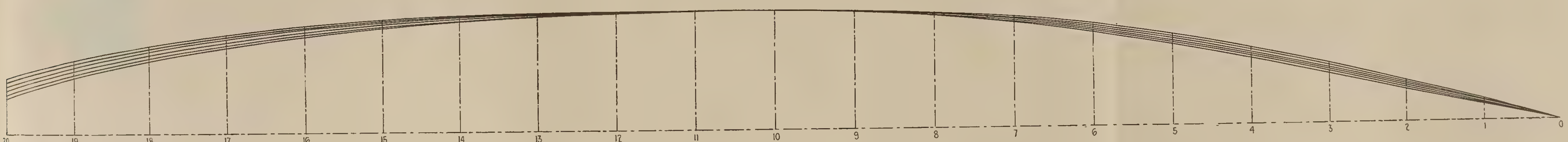
RELATION OF BEAM TO HEIGHT OF METACENTER



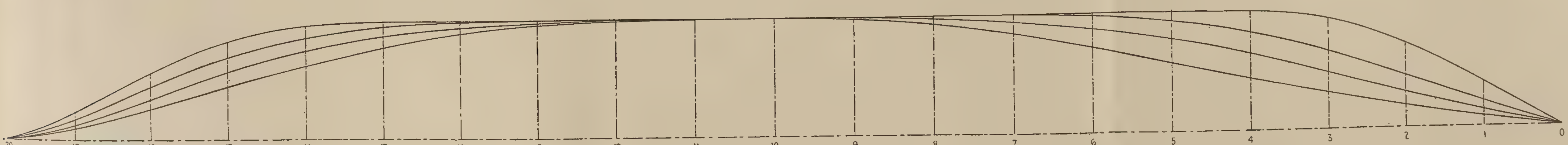
Series "A" (With Parallel Middle Body) Fig. 1.



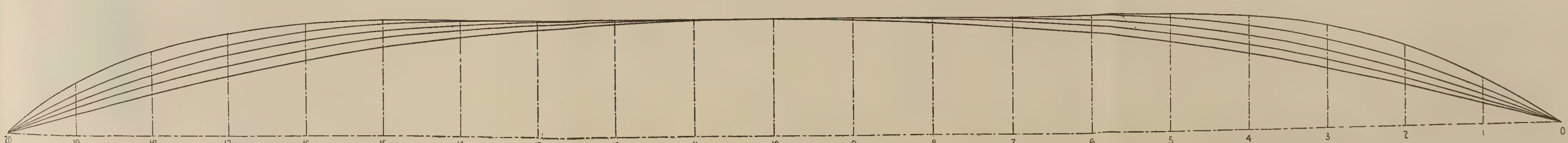
Series "B" (Without Parallel Middle Body) Fig 2



Series "C" (Broad Stern High Speed Type) Fig. 3



Series "D" (Hollow Entrance and Run) Fig. 4.



Series "E" (Convex Entrance and Run) Fig. 5.

Plate IV.—Typical Load Waterlines

Standardization of Ships' Details

FOR three years shipbuilders in Great Britain have been considering the standardization of ships' details, principally deck and other fittings. This movement was taken up in 1917 by the North East Coast Institution of Engineers and Shipbuilders with the formation of a ships' fittings committee, whose first report, presented in April, 1919, recommended standards for bollards, fairleads, mooring pipes and hawse pipes. Subsequently this committee was replaced by the North East Coast Institution Panels which are carrying on the work in conjunction with the British Engineering Standards Association. The details at present under consideration of the Panels are as follows:

Panel 1.—Bollards, fairleads and mooring pipes. Panel 2.—Hawsers, ropes, rigging screws and rigging gear. Panel 3.—Boat davits, derricks, derrick fittings, stanchions, all ladders and ladder fittings. Panel 4.—Windlasses, capstans, winches, steering gears and deck machinery. Panel 5.—Deck and hatch fittings, watertight doors, manhole covers, sidelights, ventilators, bunker and galley fittings. Panel 6.—Cabin fittings and beds, including electric light fittings not dealt with by the electrical committee. Panel 7.—Sanitary fittings and all pipe and pumping arrangements. Panel 8.—Anchors, cables and chains.

The North East Coast Panels will be augmented by representatives from the Board of Trade, the classification societies and the North East Coast shipbuilding and ships' auxiliary manufacturing companies, and they will also co-operate with similar panels established in the Clyde shipbuilding district.

A New Departure in Side Launching

SOMETHING unique in the annals of side launching has been successfully accomplished on the *Canadian Otter* built to the order of the Canadian Government by the British American Shipbuilding Company, Ltd., Welland, Ont.

The ship's dimensions necessitated the usual cutting for passage through the Welland Canal. To eliminate the cost and time of dry docking for this purpose, the hull, while on the stocks, was first fitted complete, but later a section of plates just forward of the boiler room bulkhead was unbolted, removed and marked for reference.

The weights at launching condition and the centers of gravity of each part were calculated and the loose plates stowed in the fore end for trimming. A temporary watertight wooden bulkhead was fitted near the break to prevent the flooding of the forward hold and also to insure greater buoyancy.

There was a drop to the water of 5 feet 4½ inches for the after end and a drop of 3 feet 6 inches for the forward end. From observation the greatest angle of heel was found to be 34 degrees, and the time elapsing from starting to reach this position was 6 seconds. In three seconds more she righted herself and lay on a comparatively even keel.

A sister ship is on the stocks at present and will be launched in a similar manner in the near future.

Fig. 1.—S. S. *Canadian Otter* Cut Apart on the Ways to Enable Her Passage Through the Welland Canal

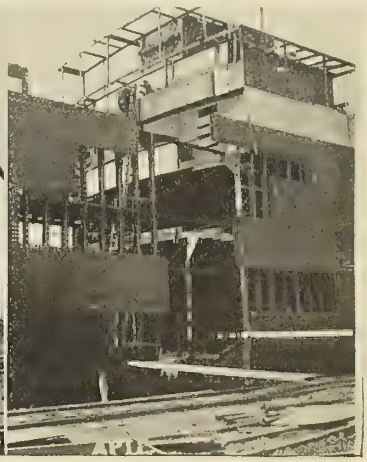


Fig. 2.—Section Where Shell Plates Were Removed

Fig. 3.—Launching the After Section

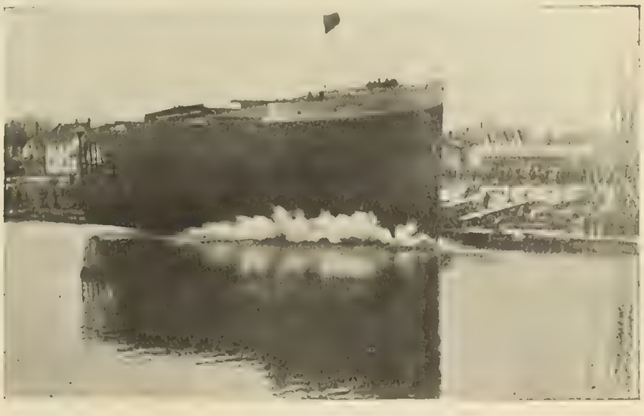
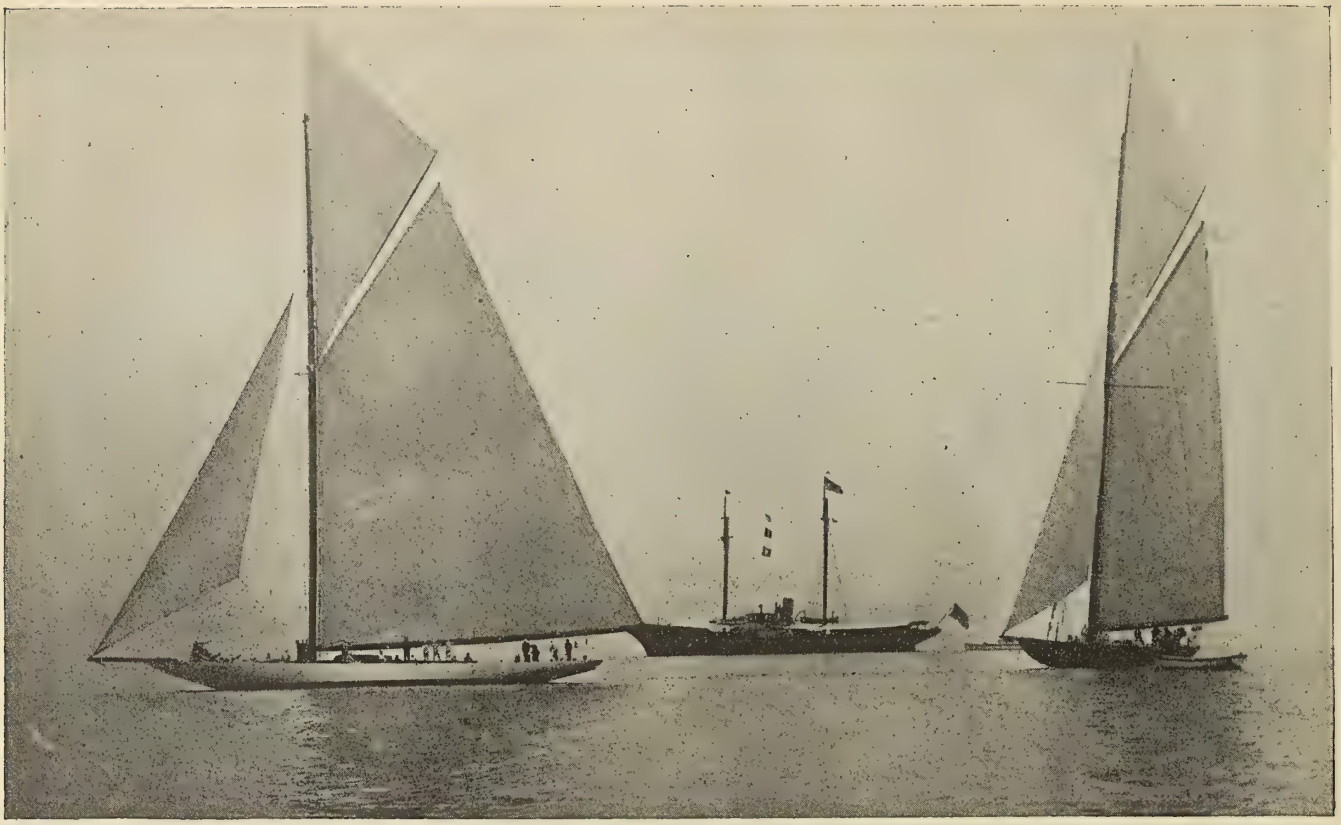


Fig. 4.—Bow Section Entering the Water



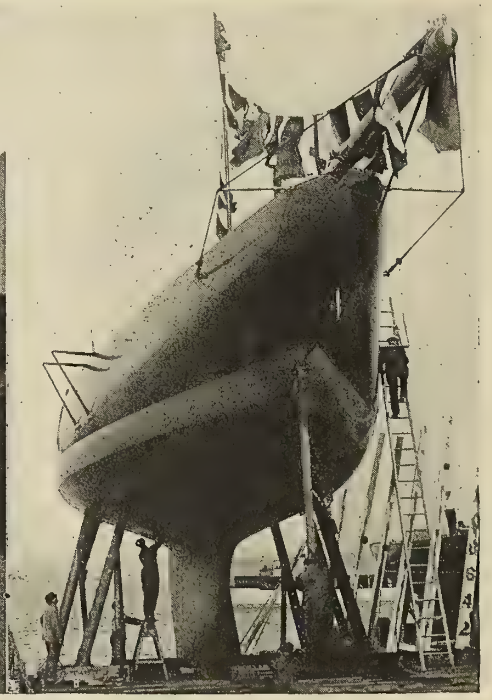
(*Photograph copyright by International, N. Y.*)
Fig. 1.—*Resolute* Leading *Vanitie* at Start of First Elimination Race Off New Haven, Conn.

The International Yacht Race

BY C. A. MC ALLISTER

NAVAL architects and others interested in the building and operation of ships are certainly entitled to a diversion after more than five years of strenuous efforts to produce tonnage, both naval and mercantile, to fill up the gaps caused by the rapacious submarines. After the seriousness of that great undertaking, the pull-

Fig. 2.—Crew of *Resolute* at Work on New Mast



(*Photographs copyright by International, N. Y.*)
Fig. 3.—Launch of *Shamrock IV* at City Island, N. Y.

ing off of a real, old-time, sure-enough international yacht race will have a tonic effect on the jaded nerves of mariners afloat and ashore. It hardly seems possible, but it is a fact, nevertheless, that the last race for the Queen's cup was held in 1903, just seventeen years ago; it is high time, therefore, to have another chapter of these great events.

Of course, this coming race was originally scheduled for the year 1914, and the challenger, the *Shamrock IV*, had arrived and was making preparations for the contest that year when the event was called off, owing to the outbreak of the great war. The American yachts, the *Vanitie* and *Resolute*, had about completed their trial races, but no decision had been made as to which of them should be selected for the honor of defending the cup. Consequently, the preparations for the great contest this year have been merely a taking up of the programme so rudely set aside six years ago. Opportunity has been taken, however, of making slight improvements in all three yachts. These changes have now been completed, and whether or not they are betterments over the original design will probably never be known. In the case of the visiting yacht the alterations were comparatively extensive, embracing, as they did, the cutting of about 6 tons of lead from the keel, altering the rake of the rudder and performing an extensive marine surgical operation on the forefoot, whereby hollow lines were replaced by convex lines, with the evident intention of shortening the waterline length, which largely determines the sometimes vital question of time allowances.

The exact lengths of the waterlines of the contenders are not yet known, and will not be until the official measurer of the New York Yacht Club has executed his particular function. It is understood, however, that *Shamrock IV* as originally constructed would have had to give either of the Yankee sloops a considerable time allowance, which in a close race might have kept the cup on this side, regardless of

(*Photograph copyright by International, N. Y.*)
Fig. 4.—*Shamrock IV*, the Challenger

(*Photograph copyright by International, N. Y.*)
Fig. 5.—*Resolute*

(*Photograph copyright by International, N. Y.*)
Fig. 6.—*Vanitie*

the elapsed time over the course. It may not be generally remembered, but the fact is that the race this year will be between sloops much smaller than those participating in the last four or five series of races. Whereas the *Columbia* and *Reliance* and the original *Shamrocks* were sloops of about 90 feet waterline length, the present contestants are all in the close proximity to 70 feet long on the waterline. To look at their spars and racing sails, however, it does not look as if there was such a great difference in size.

American Yachts Evenly Matched

At the present writing, June 11, the question of whether the *Resolute* or *Vanitie* will be selected as the defender of the cup is problematical. To date the honors are as nearly even as it is possible to judge them. In all three of the yachts the designers' ideas have been to get the maximum of driving power from sail spread with the minimum of weight. The margin of safety of spars and rigging has been reduced to a very small factor, as evidenced by the several mishaps which have already befallen the spars of both the *Shamrock IV* and the *Resolute*. The *Vanitie* has been more fortunate, or perhaps we could say that she has the advantage of a larger factor of safety in the design of her spars and rigging. In making the decision as to the best American yacht, the record of the *Vanitie* for freedom from mishaps should be given the most serious consideration. It will matter very little in the ultimate outcome of the race series if the American contenders may have been leading at a certain period of the race and lost out through the breaking of a gaff or the carrying away of a stay. It's the first boat over the finish line in the majority of the series which will take the cup. Accidents are no excuses. There is little use, therefore, in having the fastest boat unless she can hold together and get over the line first.

Should the *Vanitie* be selected, it will be bronze versus wood in the international contest—the most up-to-date material for ship construction pitted against the first material ever used by man to float on the seas, as it is reliably reported that Noah saved the human race by building his ark of wood. It is interesting to note, in retrospect, the varying conditions under which these classic contests have been run. Originally when the *America* went to England and took the cup it was a contest of radically different types, the Yankee skimming dish (broad beam, light draft and centerboard) against the generally accepted channel type of English cutter, with narrow beam and great depth. In succeeding races these radical differences of type have gradually been eliminated, as each side has by evolutionary processes adopted the best points of their antagonists. Today it would be rather difficult to differentiate between the contenders so far as type is concerned. The same long overhanging bows and sterns, the same types of lead keels, approximately the same beams, and each provided with dagger centerboards leave little points of difference in general to be discussed.

Distinguishing Features of the Contenders

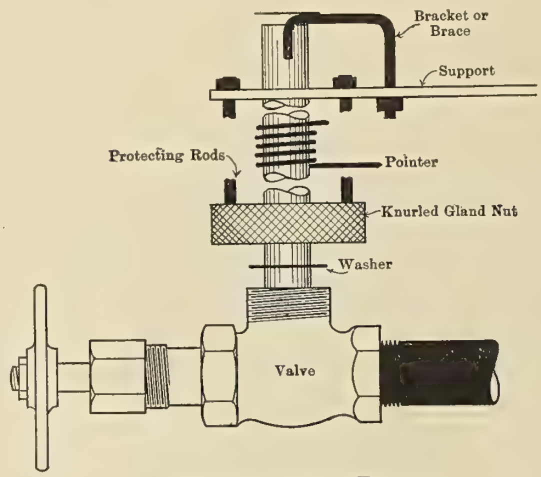
From a spectacular standpoint the approaching races will be well worth seeing to all who love ocean sports, and almost everybody does. Even though the contestants will be smaller sloops than those in the immediately preceding races, their enormous spars and sail spread make them easily distinguishable from any other yachts in these waters. Following precedent, Sir Thomas Lipton, out of loyalty to his native land, has the *Shamrock IV* painted green. If the *Vanitie* is selected, her polished bronze sides will glisten in the sunlight so that the contestants may easily be distinguished miles away. The British yacht ensign with the insignia of the Royal Ulster Yacht Club emblazened on the blue field will attract considerable attention, with its golden crown above a white circle, in which is worked a large bloody human hand, known as the Blood Red Hand of Ulster. Sir Thomas Lipton has in all his previous contests for the cup proved himself to be a prince of sportsmen, and all Americans wish him well, with the solitary exception that he does not take the much coveted cup.

Old timers at City Island, now the center of yachting activities in this country, who have seen all of the yachts for many years past, do not feel so sure but that Sir Thomas will be rewarded this year, for, as one of them stated as he shook his head ominously, "This will be the thirteenth of the series of races, and I never did like that number."

Gage Glass Fittings Made from Old Valves

An inexpensive and servicable gage glass fitting for lubricating oil tanks or for any other low pressure oil storage tanks can be made from an old valve as shown in the illustration. In this case an angle valve is used, but a globe valve will answer the purpose as well.

A solid brass plug should be threaded and screwed into the valve as far as the valve is threaded. A hole the size of the inside diameter of the gage glass should be drilled through the plug. Next bore the plug out just large



Improvised Gage Glass Fittings

enough to admit the gage glass, leaving a shoulder on the plug for the glass to rest on.

The outside of the valve should be turned down just enough to true it up and then threaded with fine threads about 20 to the inch. A thin washer will answer the purpose of a stuffing box gland, as there will be no pressure to resist.

If no gage glass protecting rods are to be used, the gland nut should be made smaller. Three or four protecting rods are enough and are made from any small size stiff wire. One fitting will be enough, as the glass can be left open on top; 3/16-inch or ¼-inch flat stock will answer for the top support of the glass. To keep dirt from falling in the top, a cover can be made and soldered to the holding down rod or brace made from ¼-inch stock.

A coiled spring, as shown, is made to answer the purpose of a pointer, and after calibrating the tank and transferring the measurements to a scale on the outside the pointer can be moved from day to day showing the amount drawn. Ideal.

Turbo-Reduction Gears in Practice

BY COMMANDER H. C. DINGER, U. S. N.

Recent descriptions of turbo reduction gears for both naval and merchant vessels have dealt principally with the details of construction, the manner of cutting the gears, the economy resulting from their use and the advantage in weight saving over directly connected units. In this article, however, the author takes up from a practical standpoint the actual operation of the gears on the vessels, defects in installation, troubles in operation and the care required to avoid such troubles as have been encountered.

SATISFACTORY reduction gear sets of almost any power desired can be made by a considerable number of shops both in this country and in England. Furthermore, an enormous number of marine turbo-reduction gear sets are being made and are being operated. Practically all the pioneer sets made by Parsons have operated successfully from the start. Nearly all the sets built in the United States have been successful. Some failures have been due to design, others to inaccurate workmanship and installation, and a greater number to improper operation or failure of the lubricating system. Reduction gears are, in fact, no longer a novelty in marine work, and though the ultra conservative may not take much stock in the "new fangled contraption," which has at times given trouble, chiefly from the neglect to see that it got oil, marine gearing is here to stay for some time and may be looked upon as the accepted steam plant for all merchant craft, except for small powers where the reciprocating engine will still hold on for some time.

The most essential thing for successful operation of the reduction gears is to have an absolutely reliable lubricating system and to be particularly careful that no water or dirt of any kind gets into the system. Water in the oil is extremely dangerous. A bearing may run with a little water in the oil, but the gear will not. The presence of lint or similar substances in the oil system is especially to be guarded against, since it may plug up the oil sprays. The importance of absolute cleanliness of the interior of the gear case cannot be exaggerated. The greatest possible care must be exercised that pieces of gasket material used in any of the joints in oil piping do not find their way into the oiling system. A very careful alinement and a close, accurate adjustment of the pinion bearings is essential, as any extra back lash will cause trouble.

Turbo-reduction gears are now largely fitted on both naval vessels and merchant ships. The gears are of different types and manufacture, namely, Parsons, Westinghouse, Falk, DeLaval, and gears made by the General Electric Company, including Alquist patents. Various other shops, including the Fore River plant at Quincy, have also made gear. The planetary gear made by the Poole Engineering Company has been successfully applied in the Ford *Eagle* boats. The Parsons and DeLaval gears employ comparatively small teeth and usually have a single reduction. The other gears usually have a coarser pitch and the Falk gears employed on Curtis turbines for destroyers have a much coarser pitch and larger teeth than are ordinarily employed by other makers.

Gears may be arranged for either single or double reduction. Single reduction gears have a gear ratio of 1-4 to 1-24. The latter figure is about as high as appears desirable to go with single reduction. If a greater reduction is necessary, a double reduction should be resorted to.

In naval work, single reduction sets are generally used, because the speed of the vessel is high and this permits of using higher propeller speeds than are considered desirable in the case of 10 or 12-knot freighters. A large number of merchant installations, therefore, employ double reduction sets. This makes a more clumsy gear set, but a more economical turbine and propeller, as it permits a high speed for the turbine and a low or economical speed for the propeller.

By some manufacturers the idea is exploited that for large marine reduction gears a floating frame or flexible alinement is necessary or at least desirable. As a matter of fact, most of the sets in operation, and this includes the largest ones installed in light, non-rigid vessels, are of the rigid type, and some have been in operation for many years. As far as practice has determined, a flexible gear is not necessary and moreover is probably less desirable than a rigid gear. What is required in a successful gear is minute accuracy and rigidity, adequate strength and absolutely reliable lubrication. In cases where a rigid non-flexible gear has been designed with adequate margin, and where there have been accurate workmanship and correct adjustment, they have worked with general satisfaction. On the contrary, numerous attempts to construct a gear that will be flexible have not been successful. In other words, an attempt to cure an assumed defect has introduced difficulties of much larger magnitude than the assumed one that is to be cured.

The following summation is made by one of the most successful manufacturers which has built marine reduction gear sets in the United States:

(1) The twisted or helical gear is the only type suitable for the transmission of large powers at high speeds, due to the fact that the load is transferred from tooth to tooth without shock or vibration.

(2) Helical gears should be double, with the teeth inclined at equal angles in order to eliminate axial thrust.

(3) For high pitch speeds the angle of the helix and the number of teeth must be so selected that the maximum number of teeth will be in contact at all times.

(4) The cutting apparatus and methods must be such that correct pitch, angle and tooth contour are produced. Hand correction or finishing will not produce a correct gear.

(5) The most suitable shape of tooth is the involute, which gives a true line contact on each tooth so long as the tooth is in mesh and irrespective of considerable variations in the distance between the centerlines of the shaft, as due to wear of bearings.

(6) After cutting, the teeth must be polished uniformly

to remove scratches and inequalities left by the cutting tool. This can be done only by mechanical means and not by hand scraping or filing.

(7) The tooth pressure must not be so high that the film of oil will be squeezed out from between the teeth. This maximum pressure is influenced principally by the peripheral velocity.

(8) The gear and pinion must be rigidly supported so that their axes remain parallel. Only by this means can the teeth be made to retain their original correct contours, and to operate noiselessly, efficiently and without vibration. Flexible supports open up a way for vibration and momentum effects that otherwise would not exist. No flexible member can accommodate itself to inequalities of pitch of a rapidly revolving pinion or gear, on account of the short period of time in which adjustments would have to be made and the great momentum that would have to be generated or destroyed at each oscillation. Neither can a flexible frame or support compensate for bending of the pinion, and it cannot compensate for twist of the pinion correctly, since the twist per unit length varies from a maximum at the end of the pinion where the power is applied down to nothing at the free end. The fact that rigid frame gears are, and have been for years, running continuosly with high tooth pressures and at the highest peripheral speeds shows that the complications of a flexible frame are not essential to securing satisfactory operation.

Merchant marine work is characterized by continuous operation at full load, and for this reason it would not be wise to work with extreme tooth pressures, even were it possible to compensate correctly for distortion. By choosing properly the diameter of the pinion in relation to its length, cross bending and torsion become very small indeed. For example, in a 6.6-inch diameter pinion of 24-inch total face having three pinion bearings and transmitting 2,000 brake horsepower at 3,600 revolutions per minute, the extreme possible deflection due to bending is only .0005 inch, and the distortion due to twist only .00045 inch, making no allowance for distribution of the pressure by varying thickness of the oil film.

General Considerations

For medium powers, when space is not restricted, a gear can be used that has a good margin of tooth pressure, and the problem of securing a satisfactory gear is not a very difficult one. The metal is not stressed to any great extent, and a solid and rigid housing for the gear can be provided. However, when we come to the very high powers in confined spaces, such as are required on destroyers and scouts, the problem becomes much more difficult. Tooth pressures are high, the metal of pinions is highly stressed, rigidity of bearings and bearing supports is more difficult to secure and the lubricating problem is also more difficult. But, if a high degree of accuracy in the cutting of the teeth and in the alinement and adjustment of all the parts is secured, the problems are satisfactorily solved.

Lack of satisfactory conditions in regard to alinement and accurate mesh is usually indicated by noise, and such noise is intensified by lack of balance in the various parts.

By reason of even slight lack of accurate teeth and proper alinement, some gears may be very noisy. Sometimes this noise is reduced by some slight wear in service, but such improvement is not to be depended upon. If a noisy gear is present, it is a pretty safe guess that there is something wrong with the alinement of the bearings, the meshing or the cutting of the teeth.

Some very large gears, DeLaval, Parsons and Westinghouse, which are very heavily stressed, have been machined and installed with such accuracy as to be free from any objectionable noise.

Laminated Gears

A considerable number of gears built up of laminated rings have been built and tried. The principle examples of this type of gear have been put forward by the General Electric Company under Alquist patents. The idea of the laminations is to get flexibility and to permit of using small teeth. The practical results with these gears do not indicate that the desired results are secured. While quite a number have operated successfully when new, there have been a large number of cases of teeth breaking. In fact, the gear seems, in a very contrary manner, to do the very thing it was specially designed not to do. Apparently, in practice, wear is uneven on the several laminations and after a while the hard laminations take the load and become overloaded and then teeth are broken. In view of the fact that solid teeth with rigid bearings have given very satisfactory results in the course of years of service, there seems to be no reason to use laminations.

Lubricating Systems

The most essential thing for successful operation with reduction gears is to have an absolutely reliable lubricating system and to be particularly careful that no water or dirt of any kind gets into the system. For lubricating gears, a heavy straight mineral oil or mineral oil with a slight admixture of lard oil appears to give the best service. Lard oil should not be used unless absolutely needed, since the acid it contains may start corrosion. If a gear is scored or rough, it may be necessary to use lard oil for a time until the surface is again smooth.

In most cases, the lubricating system for the gears is the same as that for the turbine bearings. Here it is usually best to use as heavy an oil as the turbine bearings will stand. Light oils are usually better for the turbine bearings, while they are not best for the gears. But usually a mineral oil that will answer for both can be found. For the reduction gears, also, a fairly high oil pressure is desired, usually a higher pressure than would be required for the turbine bearings alone.

Different manufacturers have different arrangements for their lubricating system. In some types, particularly Westinghouse, the lubricating system is attached to the gear sets and pumps, which are of spur gear type, are driven from the high speed pinion shafts by means of spiral gears. Other systems, and thus far all United States naval installations, are independent steam driven lubricating pumps. In some cases, the oil system for the gear sets is independent of the system for the turbine bearings and thrusts; in others there is only one system for both gears and other bearings.

From the point of view of securing the most satisfactory lubricating system for both gears and bearings, separate systems are better, but from the point of simplicity a combined system is to be recommended. For large installations, separate lubricating systems with separate coolers appear to be justified. In such cases the oil and oil pressure most suitable for the gears can be used, and also that which best suits the bearings. Where there is only one system, a compromise between the bearings and the gears has to be reached; furthermore, if the lubricating system for the gears is separate, there is less chance of water, lint or pieces of metal getting into the oil from the gears. Of course there is a little more to look out for.

In general, independent instead of attached oil pumps are preferred, because then a better regulation of the supply of oil is possible and adjustments can be made during operation.

On merchant vessels a gravity system of lubrication is generally employed, there being a supply (also settling) tank located so as to be about twenty feet above the bearings. Oil pumps are provided to pump the oil from the drain tank through oil coolers and filters to the gravity supply tank. Oiling systems employing these features have been elaborately worked out by both the DeLaval and Westinghouse companies for the marine reduction gear sets made by these firms. These systems also have automatic control valves for the oil pumps and automatic by-passes for the filters or strainers, the idea being that the system should be as foolproof as possible and automatically guard against any possible stoppage of oil.

The DeLaval oil purifier or separator for use in connection with marine lubricating systems has recently been introduced. This device is similar to the well-known cream separator. It is piped up to the lubricating drain tank, and by passing the oil through it the oil is thoroughly cleaned of any water, dirt or other foreign material it may contain. This purifier can be operated both when under way or when in port, and by its use the lubricating oil can be kept clean and absolutely clear of water.

Points in Operating

The following are some points to be specially noted in connection with handling reduction gears:

Water in the oil is extremely dangerous. A bearing may run with a little water in the oil, but the gear will not. Water in the oil, even if only in minute quantities, is probably responsible for the pitting of the surface of the gears.

The presence of *lint or similar substances* in the oiling system is specially to be guarded against, since it may plug up the oil sprays. Waste should not be used to wipe out the gears or any bearings, and particularly not for cleaning out any of the oil tanks.

The importance of *absolute cleanliness* of the interior of the gear case cannot be exaggerated. All castings in contact with the oil must be thoroughly cleaned to remove all fins, core sand, scale or other foreign matter. No paint, enamel or other coating that may cover up these foreign substances should be permitted.

The greatest possible care must be exercised that any *pieces of gasket* material used in any of the joints in oil piping do not find their way into the oil system. Lubricating pumps should have metallic packing throughout.

A very careful *alinement* and a close and accurate adjustment of the pinion bearings is essential, as any extra back lash will cause trouble. The bearings must be adjusted to bring the pinion in the proper position when it takes the load.

Although great accuracy in adjustment of bearings is essential the pinion bearings must not be set up too tight or the journal will wipe. For a four-inch shaft a clearance of at least eight-thousandths of an inch should be allowed. The reason for this is that the pinion when put under stress will tend to rise up slightly at one end and twist, and if the bearing has enough clearance, this slight skew movement can take place in the oil film, while if it is set up too tightly the journal will wipe at opposite corners.

Wearing of shoulders on teeth of either pinion or wheel —it is important that the engaging wheels have the teeth of same length and accurately adjusted in line. If one is longer than the other, or if they are not in line longitudinally, a circumferential shoulder may be worn on one or the other, which in time will cause trouble and even cause teeth to cut and break. To avoid this, the ends of the teeth should be chamfered off, and when any signs of a shoulder appear it should be scraped out and the edge making it cut away.

> A common source of trouble in operating reduction gears is scoring of the gears, due to defective lubrication or the presence of some piece of metal. In such cases the scored surfaces should be carefully cleaned out and smoothed up. In well cut and well lubricated gears the wear is very slight, though in the course of five or six years the wear on the pinion teeth may be sufficient to require the installation of a new pinion. In installing reduction gears, the gear wheel should be lined up with the tail shaft. The pinion bearings, usually three, must be parallel, both in a vertical and in a horizontal plane, to the journals of the gear wheel. The position of the tooth mesh largely affects the smooth operation. As a rule, the clearance at the root of the thread should not be large and the adjustment should be such that there is plenty of room for the oil film and very little more. The clearance on the sides of the teeth must be sufficient to allow for any expansion as the gear heats up, and sufficient for an oil film under any conditions.

Noisy Gears

The cause of noisy gears is, of course, some slight inaccuracy in the cutting of the teeth or in the adjustment or fitting of the parts. This initial sound may be intensified or deadened by various surrounding conditions, such as the resonance of the gear spider or gear cover and casting, so a rather noisy gear may otherwise operate quite satisfactorily. The presence of objectionable noise is, however, an indication of some inaccurate work or adjustment. Lack of static or dynamic balance of either gear wheel or pinion may intensify the noise and may even cause certain deflections which may be responsible for it. Frequently a noisy gear can be improved by substituting another pinion. The shape of the cover over the gear case, its supports and the material it is made of may add to or subtract from the noise. Sheet metal acts more as a sounding board than does a cast iron cover. Changing the mesh of the teeth so that they mesh closer may sometimes reduce the noise. Of course, one of the first things in the elimination of noise is to check up on the alinement. The alinement of the pinion bearings may be thrown out by the bolting up of holding down bolts, hence this should be verified both before and after these bolts are set up.

Gears, after being cut and before being used, should be ground in under load, using an oil bath and ground glass or powdered silicon. This process should continue for a number of hours. It cleans and polishes the contact surfaces and removes any small humps, irregularities or sharp points which might be broken or crushed if the gear were set to work at full load without this grinding process. If there is doubt as to the thoroughness of the grinding process in the shop, the gears may be ground in in the vessel after the installation is complete by having the turbines revolved slowly under steam.

When all other means of reducing noise have been exhausted, a very considerable reduction in its intensity and general objectionability can be secured by fitting sound arresting covers over the surface of the gear case. The cover is made of a heavy layer of cow hair felt, sometimes called acoustic felt, held in place by wood or sheet metal

lagging. The spider of the gear wheel may also be packed with some sound arresting material to reduce its resonance.

There are also cases where pinions when tried are found to be noisy and on examination show unsatisfactory contact. In such cases pinions have been put through a hobbing machine to skim off any small inaccuracies and then when tried again have shown better contact and operate with less noise. The explanation of this is that certain stresses have been released in the pinions when put under full load, and these have caused very slight local warping. The recutting removes the effect of such warping and any other slight inaccuracies. The pinion after this treatment will probably work satisfactorily.

In the case of Falk gears in destroyers the recutting of pinions after they have been tried under power and found to be noisy has almost invariably reduced noise. In some cases the recutting of the gear wheel has been resorted to before satisfactory operation as to noise was secured. In this case it was thought that the gear wheel had warped due to standing in one position for several months, or else the wheel casting may have been too green when the cutting was done and distorted afterwards. In general, it has been found that noisy gears can be improved by having them recut. It would also appear that the cutting of the teeth should be accomplished in at least two operations, one a heavy rough cut and the other a light finishing cut. This second cutting will be more exact and accurate, as the amount of metal removed is small and there is less tendency for the tool to chatter or tear the metal.

Damage to Gears and Remedies

Repairs to gears are possible at sea. It must not be supposed that some slight accident, due to failure of oil or the presence of some foreign substance in the gear case, will render the gear set useless. A most ordinary case of trouble will be where scoring has occurred due to defective lubrication or the presence of some piece of metal. In such cases the scored surfaces should be carefully cleaned out and smoothed up, using a file scraper carefully and then a carborundum stone. The work must be very carefully done, but some rather rough surfaces can be restored to a satisfactory working condition.

In case some part of a tooth or teeth are bent or dented, it may be possible to remove the hump opposite the dents by scraping, so that the good surfaces of the gear and pinion teeth may continue to mesh properly. If the teeth are damaged or bent to such an extent that scraping will not suffice, the pinion may be removed and the damaged part of the pinion or the part in wake of the damage on the gear wheel can be turned down to below the root of the teeth, smoothed up and then replaced. The gears can then operate at reduced power until a new gear or pinion can be supplied. Thus, a very considerable part of the tooth surface may be damaged and the gear still be made to operate at reduced powers.

Wear

In well cut and well lubricated gears the wear is very slight, though in the course of five or six years the wear on the pinion teeth may be sufficient to require the installation of a new pinion. Spare pinions are kept available for use in such emergency. Gears frequently develop a sharp knife edge caused by a pushing or rubbing over of the metal due to the slight amount of sliding contact. When the knife edge develops, it should be cleaned off by scraping and stoning. The knife edge usually develops during the first few months of service and then the action stops. It should not, therefore, be a great cause for worry.

A certain amount of pitting is sometimes observed on the flanks of the teeth of large gears. Usually this is observed after the first few months of service. The pitting shows itself in minute shallow holes and apparently small flakes of metal break out of the surface, leaving the hollows. This pitting is most prominent in the region of the pitch line where rolling action occurs, but it may be found on any part of the tooth flank. Various causes for this pitting have been assigned. If the surface is not absolutely smooth there may be some high spots or irregularities. When pressure is applied, these minute high spots may be crushed or rubbed off, leaving the depression. A lack of homogeneity where hard and soft spots are formed may also produce a similar action. Particles of water in the oil whereby the oil film is broken in spots and contact of metal produced may also be responsible for some of the pitting that is found.

Corrosion

The teeth and the journals may be rusted and corroded due to the presence of water, either fresh or salt, or to acid in the oils. The gears should not be allowed to stand idle long without examination for rusting. If rusting and corrosion take place, the water or acid should be eliminated at the first opportunity and the surface stoned with an oil stone or fine carborundum stone and the gear teeth cleaned with kerosene (paraffin) to take away any of the grit and to cut out any heavy particles of oil and rust that may be in out-of-the-way places. One of the serious dangers caused by corrosion on the gears is that flakes of rust fall off and get into the lubricating system. Rust may also form on the inside of the casing and gear cover and the flakes may become objectionable. No definite coating, other than zinc paint, to prevent this rusting is as yet known to the operating service. Keeping water out of the oil is, of course, the most effective way of arresting any rust inside of the gear casing.

Points in Alinement

The gear wheel should be lined up with the tail shaft. This fixes the position of the gear case. The pinion bearings, usually three, must be parallel both in a vertical and in a horizontal plane to the journals of the gear wheel. They are usually bored out in a machine that will give such alinement, but fitting may be necessary, and, in any case, they should be checked after installation in the vessel.

The lower pinion bearings being bedded in and in alinement with themselves and with the gear wheel, the cap brasses can be fitted and adjusted to a uniform lead. A clearance of .002 inch per inch of diameter is permissible and leads should not vary more than .002 inch. In the usual two pinion gear the caps take the load on one side, and if the lower bearings are in line and the leads uniform, the caps must also be in line.

The position of the tooth mesh is another point that largely affects the smooth operation. Logically, the gears should come in contact on their pitch circle, but due to slight variations in the cutting or modified position, due to running pressures and the nature of oil film, a contact slightly off from pitch circle may improve operation. As a rule, the clearance at the root of the thread should not be large and the adjustment should be such that there is plenty of room for the oil film and very little more.

The clearance on the sides of the teeth must in any case be sufficient to allow for any expansion as the gear heats up, and enough for an oil film under any conditions. This clearance should not be less than five-thousandths of an inch, while it seems to be inadvisable to have more than

fifteen-thousandths of an inch even on large gears. This clearance can be adjusted by moving the pinion in or out. A too great clearance seems to increase the intensity of the noise made by the gear. Some gears, however, run quite satisfactorily with a clearance of tweny-five-thousandths or even more. Note should be taken of the fact that the gears when under load may develop a fairly high working heat. The temperatures may vary from 110 to 180 degrees F., hence these temperatures should be allowed for in lining up and making adjustments.

KINGSBURY THRUSTS

Kingsbury thrusts are now usually installed in connection with marine turbo-gear sets, both as thrusts on the turbines and on the reduction gear sets. The detailed mechanism of these thrust bearings is given in pamphlets issued by the manufacturer, Albert Kingsbury, Pittsburgh, Pa. These thrusts work very well when properly lubricated, but a failure of the oil, even for a short time, will cause the bearing shoes to burn out. As soon as any heating is discovered, the engines should be slowed until the normal supply of proper lubricant is again present.

Special information concerning the operation of reduction gears made in the United States can be found in the following:

Pamphlet, DeLaval Steam Turbine Company, Trenton, N. J., marine reduction gears and oiling system for same.

Pamphlets issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., and the Falk Company, Milwaukee, Wis.

> The presence of objectionable noise in reduction gears is an indication of some slight inaccuracy in the cutting of the teeth or in the adjustment or fitting of the parts Frequently a noisy gear can be improved by substituting another pinion. The noise may be increased or diminished by the shape of the cover over the gear case, its supports and the material it is made of. Changing the mesh of the teeth so that they mesh closely may sometimes reduce the noise, but the first precaution in the elimination of noise is to check up the alinement. When all other means of reducing noise have been exhausted, a very considerable reduction in its intensity can be secured by fitting sound arresting covers over the surface of the gear case. In general, it has been found that noisy gears can be improved by having them re-cut.

INSTANCES OF GEAR TROUBLE

The following are some tabulated instances of gear trouble. Notes *A-G* are taken from the paper "Progress in Turbine Ship Propulsion," read before the Society of Naval Architects and Marine Engineers in 1918 by Francis Hodgkinson, of the Westinghouse Electric & Manufacturing Company.

Note A: U. S. S. *Neptune.* This ship was equipped with two sets (twin screws) single reduction gears and turbines, the turbines having been largely experimental and were not successful. The gears, however, operated splendidly. The turbine machinery was then replaced, and inasmuch as a higher turbine speed was considered desirable, new gears involving a greater speed reduction were also installed at this time. The designed constants of the new gears were very high and are still much in advance of our present practice.

Considerable trouble was experienced due to the teeth abrading, which was only overcome by the use of lard oil. Since that time, however, in November, 1915, no further trouble has been recorded, and the teeth at the last inspection were in good condition without any indication of wear.

Note B: S. S. *Maui.* This vessel was built by the Union Iron Works. Inasmuch as we were late in delivering the machinery, we were unable to carry out any tests on the gears in the works, and inasmuch as great store was set by the owners that nothing should go wrong on the maiden voyage, and as there was some uncertainty as to the excellence of the tooth surface, lard oil was employed as a lubricant for the first two voyages, after which mineral oil was substituted for the lard oil.

The operation of the machinery was all that could be desired for eight voyages, at which time there was abrasion of the gears due to failure of the lubrication. This was discovered in Honolulu and the ship returned to San Francisco with nothing being done to the machinery except an attempt to clean the oiling system. The tooth surfaces smoothed up considerably during the voyage.

The gears were then transposed from one side to the other in order to make what had been the astern surfaces the ahead surfaces, so as to use uninjured tooth surfaces for ahead operation.

Again, because of some uncertainty of the tooth surfaces, lard oil was employed as a lubricant and the vessel entered in government service, going to Chile for cargo and proceeding to Baltimore. During the voyage there was an accident to an oil cooler, admitting salt water to the system. The shipbuilder having provided no means of removing any water, the effect of the salt water on the lard oil was to turn it violently acid, which necessitated a complete overhauling of the machinery on its arrival in Baltimore.

On this being completed and on the trip from Baltimore to New York, trouble was experienced with abrasion of the tooth surfaces, due, it was believed, to an inferior quality of oil, together with further failure of the oil cooler, admitting enough water to the system to make an emulsion of approximately 30 percent. A better oil was substituted and nothing was done to the tooth surfaces, the vessel having made one voyage to Europe and back with no trouble so far as the gears are concerned.

During this voyage trouble was experienced with one of the turbines, causing an extensive repair because of an obstruction in one of the oil passages to the thrust bearing of the turbine, causing the thrust bearing to fail; the turbine rotor, moving endwise, completely wrecking the labyrinth packing between the ahead and astern elements and buckling the rotor.

Note C: S. S. *Golaa.* Norwegian oil tanker built by the Chester Shipbuilding Company and chartered by the British Admiralty. Put in service July 6, 1917. Made three round trips to English ports. At present in coastwise trade between Port Arthur, Tex., and Philadelphia or Bayonne. Towards the end of the last trip from Europe (February, 1918) some teeth on the starboard high speed pinion broke out. This gear was disconnected and the ship made port, using the low pressure turbine only. Inspection showed a break occurred on one helix, 3 inches from the end of the tooth face. There was no evidence of wear on any of the tooth faces, the undamaged portion of the broken tooth face indicating uniform distribution of load. This fact and the position of the fracture make certain that the accident was due to defective material.

In August of this year the high pressure turbine suf-

fered injury as a result of improper setting of the turbine thrust bearing. Shortly thereafter an accident occurred to the pinion which replaced the one originally defective. The character of the broken tooth was similar to the previous one. The broken parts have not yet been received to enable a careful examination of the material to be made.

Note D: S. S. *Sudbury.* An American freighter built by the Chester Shipbuilding Company for the Shawmut Steamship Company. It is at present being operated by the U. S. Naval Overseas Transportation Service. A few days after leaving France on the return half of her maiden voyage some teeth broke out of the starboard high speed pinion. This gear was disconnected and the ship returned to New York, using the low pressure turbine only, with which 9 knots was attained, the designed full speed being 10½ knots.

On arrival at port, inspection showed no wear, the tooth load having been well distributed on all tooth faces. Several teeth were cracked. Subsequent examination of the steel indicates defective material, most probably due to faulty heat treatment, the fracture indicating the steel had been burned. This was confirmed by discovery that some teeth in the port high speed pinion were also cracked, although no failure occurred in service. Both pinions were forged from the same billet and treated at the same time. These pinions are similar as to material and design with twenty-five other pinions now in successful operation.

Note E: S. S. *Avondale.* An American oil tanker, built by the Chester Shipbuilding Company and being operated by the Pan-American Oil Company for the United States Shipping Board. Just as the ship was leaving Philadelphia for her trial trip a heavy blade rub was heard in the high pressure turbine. Inspection indicated defective workmanship. Some of the rotating blades were loose as a result of having been improperly put in. The spindle was rebladed and the ship proceeded satisfactorily from Philadelphia to New York. This turbine is a counterpart of twelve others now in successful operation on various ships.

Note F: S. S. *West Ford.* This vessel left Seattle at 5 P. M. on July 14, 1918, on her maiden voyage to an Atlantic port. Seven hours out from Seattle oil commenced foaming out from the turbine, running over the engine room gratings. The chief engineer was called out, and instead of investigating the reason for augmentation of the oil, he was content to pump 200 gallons to a reserve tank. Later the same thing occurred, oil again running out on the grating, and later still, at 2:14 A. M., the high pressure turbine commenced vibrating so badly that it interfered with their lighting system. They shut down to remedy the matter of the lighting system, and on trying to start the turbine it required 125 pounds initial pressure to revolve it. Serious vibration was again in evidence, so the chief decided to do what he termed "crank up on the thrust." It was impracticable to anchor, so they returned to Port Townsend at 40 revolutions per minute. They then made an observation of the oil in the drain tank, and on removing the cap the oil squirted to the roof of the shaft alley. It was later discovered that an oil cooler tube had split, admitting large quantities of salt water to the oil system.

Instructions had been given that the level of the oil in the drain tank should be regularly observed, and it is incomprehensible that it was not at once obvious that something was getting in the oil system from some exterior source. Merely looking at the oil would have determined this was salt water. Then all that would have been necessary was to shut off the water service to the cooler and separate the relatively small quantity of salt water from the gravity tank, and there need have been no interruption whatsoever. The result of such neglect was for the bearings, for want of lubrication, to let the rotor down, causing considerable injury to the turbine.

Note G: U. S. S. *Arizona.* On a voyage from Cuba to the United States the teeth of one of the cruising gears scored. Subsequent investigation showed that the oil pumps had stopped and the supply to the gears had failed. The teeth were dressed up and no further trouble has been experienced.

Miscellaneous Mishaps

U. S. S. *Salem.* Fitted with General Electric (Alquist laminated) gear. After several months in successful operation a tooth on one pinion broke off. Got into mesh and cut up pinions and gear so that gear set could not be operated. New gears had to be cut. Damage apparently due to uneven wear, so that one lamination took excessive load and finally broke a tooth.

U. S. S. *Meredith.* Falk gears. A piece of hard steel about ¼ inch diameter and 8 inches long, left in gear case, was caught at the edge of the pinion and broken up. Made numerous bad dents on pinions and some on gear wheel. Presence of obstruction not discovered while in operation, but found on post trial examination. Dents and scratches were cleaned and stoned and gear has continued to operate successfully.

Luckenbach vessel equipped with laminated gears, General Electric design, double reduction; shortly after being put in service a piece of tooth broke off and cut up gear. Casualty probably hastened, due to failure on part of personnel to see that the gear received a proper amount of oil.

Katrina Luckenbach and *F. J. Luckenbach.* Gears similar to General Electric design as above, but not built by that company, double reduction. High speed pinions wore very badly, due probably to lack of oil at some time. The trouble with these gears is probably that after wear was taking place, due to some inaccuracy in cutting or lack of oil, the pinions were shifted with reference to the teeth of gear wheel, and in the new position the teeth did not mesh properly and then began cutting. It has been found that in double reduction sets of this design a proper mesh is only obtained when the pinion is engaged in certain definite positions and that when the pinion is revolved so as to change the teeth that are engaged an improper meshing results and the teeth of the pinion wear away.

New Vessel from Middlesborough

The steel screw, shelter deck steamer *Princess Olga,* built by Sir Raylton Dixon & Company, Limited, at their Cleveland Dockyard, Middlesborough on Tees, under British Corporation survey, for Messrs. M. Langlands & Sons, Ltd., Glasgow, Liverpool, etc., for their extensive coastal service, recently underwent satisfactory trials and was delivered to the owners. The principal dimensions of the vessel are: Length, 250 feet 6 inches; beam, 35 feet; depth, molded, 17 feet.

The steamer has two holds served by three hatches equipped with nine steam winches. Water ballast is carried in the double bottom, extending all fore and aft, and in the fore and aft peaks as well as in a deep tank forward.

Propulsion is by a triple expansion engine with cylinders 19 inches, 31 inches and 52 inches diameter by 36 inches stroke, supplied with steam at 200 pounds per square inch pressure by two large single ended boilers, fitted by Messrs. Richardsons, Westgarth & Company, Ltd., Middlesborough.

Design of Main Exhaust Pipes for Turbines

BY CYRUS HANKINS*

With the increased use of the turbine in ship propulsion, there is no part of the power equipment that should be given more careful consideration than the condenser, its connections and its auxiliaries. Although in most installations the turbine condenser and other auxiliaries are built by companies other than the shipbuilder, it usually falls to the lot of the shipbuilder to supply the exhaust pipe from the turbine to the condenser. It is the object of this article, therefore, to present some definite information on the design, manufacture and requirements of turbine exhaust pipes in general, which may be of assistance to the engineer responsible for the design of these parts.

THE material of exhaust pipes is either cast iron or steel plates and shapes. These two types may be again divided into exhaust pipes with and without expansion joints. Exhaust pipes of both cast iron and steel are required to be fitted by some turbine manufacturers with an expansion joint somewhere between the turbine and condenser, preferably adjacent to the turbine. The need of an expansion joint of this type is doubted by some engineers, but with a cast iron exhaust pipe it at least removes any element of doubt as to its need. For built-up steel exhaust pipes there are many successful installations without expansion joint, and unless the exhaust pipe is long and straight, which is exceedingly uncommon, there can be no need of fitting an expansion joint. When the turbines are compounded and the intermediate pipe between the two turbines might set up detrimental stresses from expansion, then it will always be safe to fit an expansion joint of some approved type.

Expansion Joints

The expansion joint when fitted in the exhaust pipe from the turbine to the condenser is usually similar to that shown in Fig. 1. The exhaust pipe (1) is made with a flange at the bottom, either internal or external. This flange is machined on the surface in contact with the copper bellows (2). If the exhaust pipe is structural, then this flange is made from an angle or is cast steel.

The cast iron ring pieces (3) are usually made in the following manner. Rings with the desired radius r and the proper cross-section are machined on all contacting surfaces, then cut diametrically with some definite loss, usually ¼ inch. Straight side pieces of the same cross-section are machined on the same contacting surfaces as the rings, and when finished to the desired length are fitted between the two semicircles. This form makes a readily adaptable shape for both the turbine exhaust casing opening and the expansion joint.

The copper bellows (3) is made up with the desired radii for all curves. The thickness of the copper used can be safely taken as about No. 8 B. W. G. for an expansion joint about 3 feet by 2 feet and increasing or decreasing in thickness proportionally for other sizes.

The flange of the exhaust opening in the exhaust casing (4) is machined in a manner similar to the flange of the exhaust pipe. The end flange of the exhaust pipe, the ring pieces and the flange of the exhaust casing are all drilled for bolts, or drilled and tapped for studs, the spacing of these bolts or studs being such as will insure a tightly compressed joint on the copper bellows. Bolts (5) for supporting the weight of the exhaust pipe are fitted on opposite sides or ends of the expansion joint. These bolts must be sufficiently flexible and have enough clearance in the holes through which they pass in the exhaust pipe flange to allow for any lateral movement resulting from expansion. The nuts on the upper ends of these bolts are so fitted as to leave about ⅛ inch clearance, which provides for a certain amount of expansion tending to lift the exhaust pipe away from the turbine casing.

Expansion joints essentially as above outlined seem to meet all needs. The question, however, of fitting an expansion joint should be decided by the requirements imposed by the turbine manufacturer and the judgment of the engineer in charge of the design of the propelling machinery arrangement.

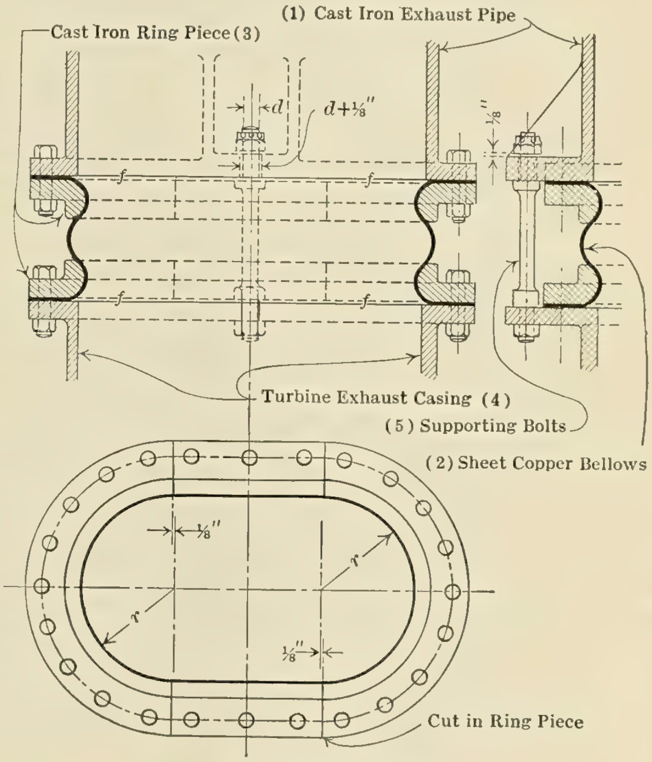


Fig. 1.—Expansion Joint

Cast Iron Exhaust Pipes

Two typical cast iron exhaust pipes are illustrated in Figs. 2 and 3. The type shown in Fig. 2 is made in two pieces in order that the castings may be more easily handled in the foundry. The external ribbing shown may be adapted to a one-piece pipe as well. The test pressure usually applied to exhaust pipes is an internal hydraulic pressure of from 20 to 30 pounds per square inch, which test pressure, being applied internally, creates stresses the reverse of those set up under working conditions. The working pressure is usually assumed for the purpose of

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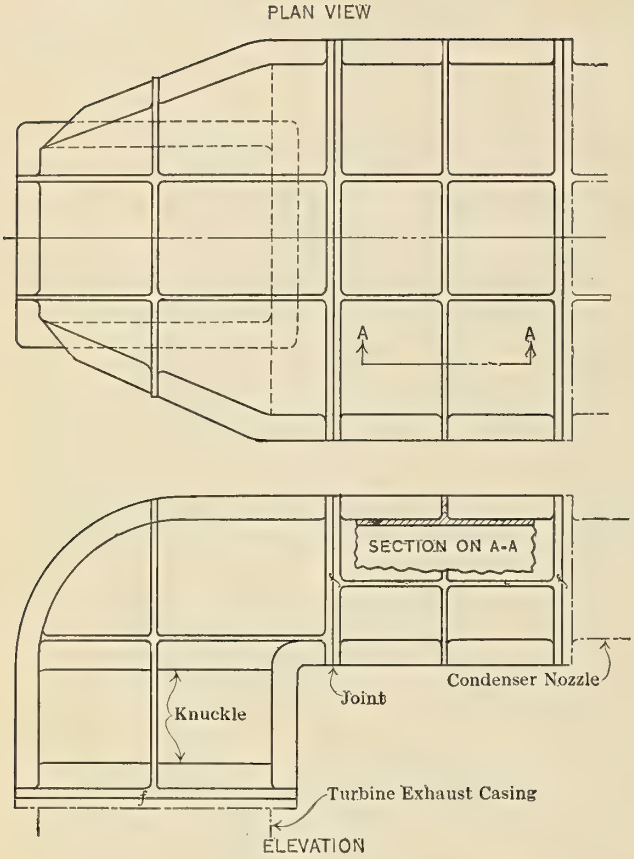


Fig. 2.—Two-Piece Cast Iron Exhaust Pipe

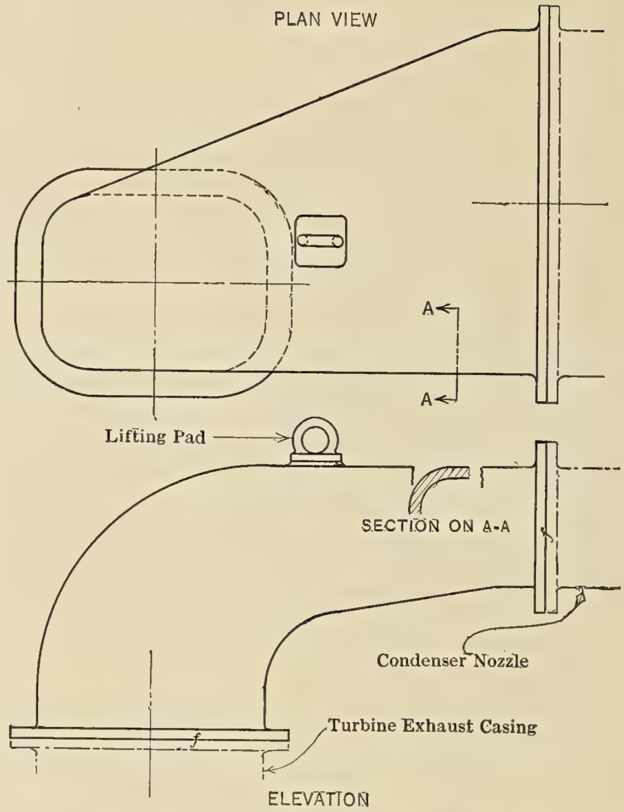


Fig. 3.—One-Piece Cast Iron Exhaust Pipe

design as an external pressure of 15 pounds per square inch.

The ribbing with a section of the plate equal to the pitch of the ribs on a pipe of the design of Fig. 2, may be taken as a beam with a length equal to the distance between supports. The section modulus of such a beam should be figured and the stresses in tension or compression in the extreme fibers found. These stresses will be those created by a load of the specified test or working pressure, figured as an internal or external pressure, as the case may be. The tensile stress under test will come at the outer edge of the ribs, and care must be taken in the inspection of the casting to see that this stress will not be localized by any defect, such as that resulting from floating sand or similar cause. In this design the stress in tension may be safely run as high as 5,000 pounds per square inch. Under the working pressure the outer edge of the ribbing becomes a compression member and the inner surface the tension member. Under these conditions the compression side will show the higher stress, and this may safely run to 7,500 pounds per square inch. Cast iron exhaust pipes should be cast in well-surfaced molds and the castings thoroughly cleaned inside and out and carefully painted, as even the best cast iron is porous to a certain degree, and any avoidable leakage under vacuum is exceedingly detrimental to high efficiency.

Steel Exhaust Pipes

The type of exhaust pipe shown in Fig. 3 has no ribbing or other stiffening, depending only on the thickness of the metal and the large curved surfaces to take the load. This design simplifies the pattern and foundry work, but is necessarily quite heavy.

Steel exhaust pipes have been the choice of most engi-

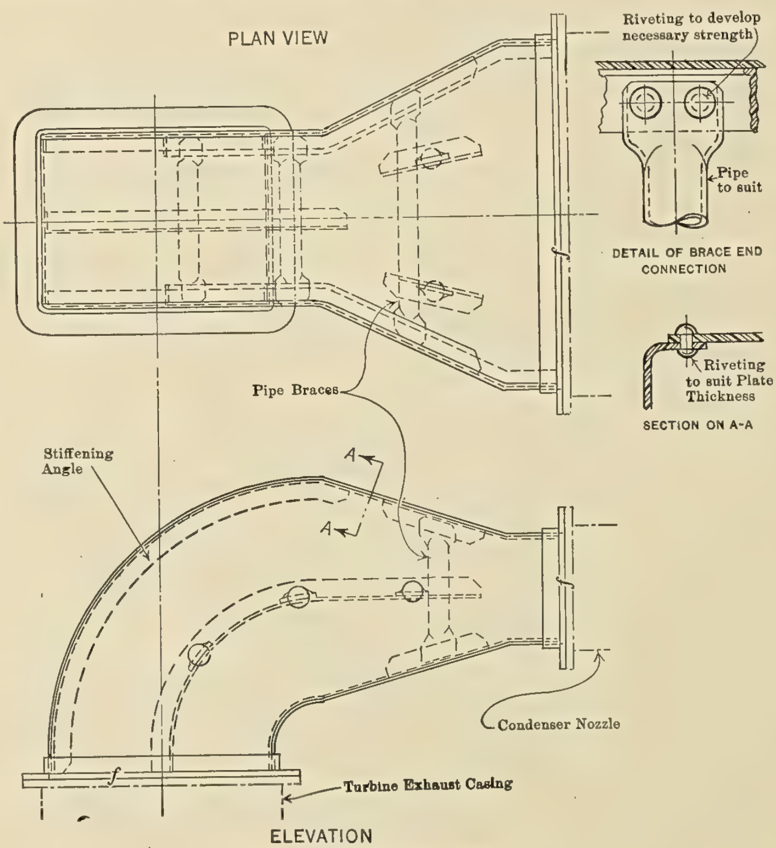


Fig. 4.—Steel Exhaust Pipe

Fig. 6.—Group of Structural Exhaust Pipes

Fig. 7.—Sections of Exhaust Pipes for Double Flow Turbines

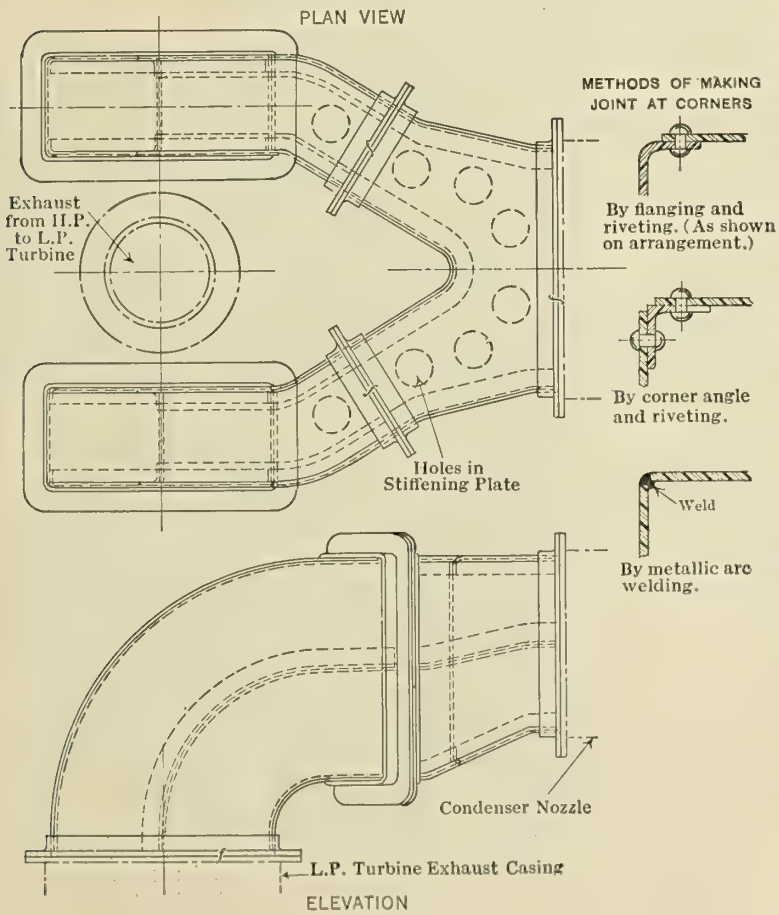


Fig. 5.—Steel Exhaust Pipe for Double Flow Low Pressure Turbine

Fig. 8.—Exhaust Pipes with Perforated Plates for Internal Bracing

neers and they usually make an exceedingly satisfactory and relatively light job. Exhaust pipes of this class vary in detail of design. Two examples of widely different types are shown in Figs. 4 and 5. Fig. 4 is a typical arrangement for a merchant ship and lends itself well to quantity production. This type necessitates only getting out templates and possibly a few forming blocks, but usually the design can be so handled as to require very little furnace work. Fig. 5 is the usual arrangement with a high and low pressure turbine installation, where the low pressure turbine is of the double flow type with two exhaust openings. The construction of these pipes follows the same shop practice as those of Fig. 4.

The test and working pressures of pipes of either design, Figs. 4 or 5, may be taken the same as for cast iron pipes and the stress calculations do not differ essentially. Struts or tension members, depending on the application of the load, are usually fitted at figured intervals on the interior of the pipe. These struts may take the form of plates running in the direction of the steam flow and may be attached to the shell by continuous angles. These plates are sometimes perforated with holes from 3 inches to 9 inches diameter to permit of perfect pressure equalization. The more common form of internal bracing for ordinary construction, however, is to use continuous angles or short angle clips running in the direction of the steam flow and attached to the inside of the pipe from which connection is made, from side to side of the exhaust pipe at the proper figured intervals, by struts of standard or extra heavy pipe. The pipe for these struts is flattened at the ends and riveted to the continuous angles or clips.

Some builders consider it good practice to use also external bracing, usually in the form of angles or bulb angles. These are arranged to run transversely to the interior angles, thereby dividing the surface of the plates into squares. The fitting of external bracing can usually be avoided by a careful study of the design and should be done, if possible, as it materially complicates the fabrication and increases the chances for leakage.

Stress Calculations for Flat Plates

The stress calculation for flat plates is a study to which many engineers have devoted much time with only limited success. Except in certain cases the methods used can be applied only approximately to the design of such irregular structures as exhaust pipes. To treat a 1-inch wide element of flat steel plate as a simple or fixed beam between definite supports, such as a corner

or longitudinal angles, will result in an apparently very high stress, which is not borne out by tests. For an exhaust pipe made of ¼-inch steel plate and fitted only on the inside with longitudinal stiffening angles, these angles being properly tied to corresponding angles on the opposite sides of the pipe, these longitudinal angles may be safely spaced 18 inches apart. A pipe thus made will stand safely an internal test pressure of 30 pounds per square inch. Curved or otherwise distorted plates will, by reason of their shape, require less support than flat plates, but the extent to which advantage can be taken of this may be best judged from the design as developed.

The end flanges of a steel exhaust pipe are usually made from a rather heavy angle, about 4 inches by 3 inches by ½ inch, or such a size as will correspond or connect satisfactorily to the turbine or condenser connecting flange. Sometimes these end flanges are left unattached until the turbine and condenser are located in the ship and are then riveted up to suit the work as found in the ship. This practice, however, prevents testing the exhaust pipe until a very late date, so the best results can usually be had by setting the condenser on its foundation, located to a template taken from the finished exhaust pipe or made to the designed dimensions of same.

Figs. 6, 7 and 8 are photographs of sections of pipes similar to those in Fig. 5. These pipes are all made from ¼-inch steel plate with corner angles 2½ inches by 2½ inches by ¼ inch, and stiffening angles 2 inches by 2 inches by ¼ inch, stayed with 3/16-inch plates perforated with 9-inch diameter holes in the straight portions only. The stiffening angles and stay plates in these pipes are from 16 inches to 18 inches pitch and, as will be noted, there are no transverse stiffeners on the outside of the pipes.

Lifting gear connections should be provided on all sections of exhaust pipes. While such provisions are not essential it makes it easier and safer in overhauling the turbine. For this purpose pad eyes or similar devices may be riveted on approximately in line with the center of gravity.

Fitting the Exhaust Pipes

In making up the joints of the exhaust pipe to the condenser and the turbine in the ship, great care should be exercised to insure the flanges coming squarely together. The connecting bolts should be of ample number and size to make it certain that the flanges can be drawn tightly together. A good quality composition or rubber gasket, about 1/16 inch, should be used in all joints. After installation, exhaust pipes should be carefully painted and all joint flanges, bolts, nuts and gasket edges shallaced. It must always be borne in mind that even the smallest air leak results in a reduced vacuum and a lowering of efficiency.

In the design and manufacture of exhaust pipes the shipbuilder has a good opportunity, with a little care in design, to effect a saving in manufacturing and installation costs, and, without doubt, in many cases quite a saving in the operating costs for the life of the ship.

European Motorship Building

BY OUR SPECIAL LONDON CORRESPONDENT

An immense amount of interest was taken last year in the details which were published regarding the novel type of internal combustion engine known as the Still motor, which is virtually a combination of a steam and an oil engine, acting as an internal combustion engine above the piston and a steam engine below the piston, the two operations taking place in one cylinder. It will be remembered that the inventor claimed an efficiency some 30 percent higher than that possible in an ordinary Diesel engine, and his claims appear to have been borne out by the prolonged tests which were effected.

Clyde Yard to Build Still Engine

One of the best known shipbuilding firms on the Clyde, the Scott Shipbuilding and Engineering Company, took out a license for the construction of this motor and a unit of one cylinder has now been built which will be thoroughly tested out. If the results achieved are completely successful, standard six cylinder engines will be built immediately for installation in large cargo vessels. The cylinder which is now undergoing trials has a diameter of 22 inches, a stroke of 36 inches and operates on the two cycle principle developing 400 brake horsepower at 120 revolutions per minute. The type of motor that will first be standardized is a six cylinder set with cylinders of these dimensions developing 2,400 brake horsepower in one unit. Both engineers and shipbuilders are watching the experiment with the greatest interest, and while some shipowners are inclined to think that the employment of steam in combination with the oil engine is a retrograde movement, the opinion is held in many circles that this is in fact an advantage, since steam may profitably be used on a motorship for driving the auxiliary plant. It would seem, however, that the first cost of the machinery would be greater than that of ordinary Diesel engines, but upon this point it is impossible yet to express any final opinion.

British Shipowners Contracting for Motorships

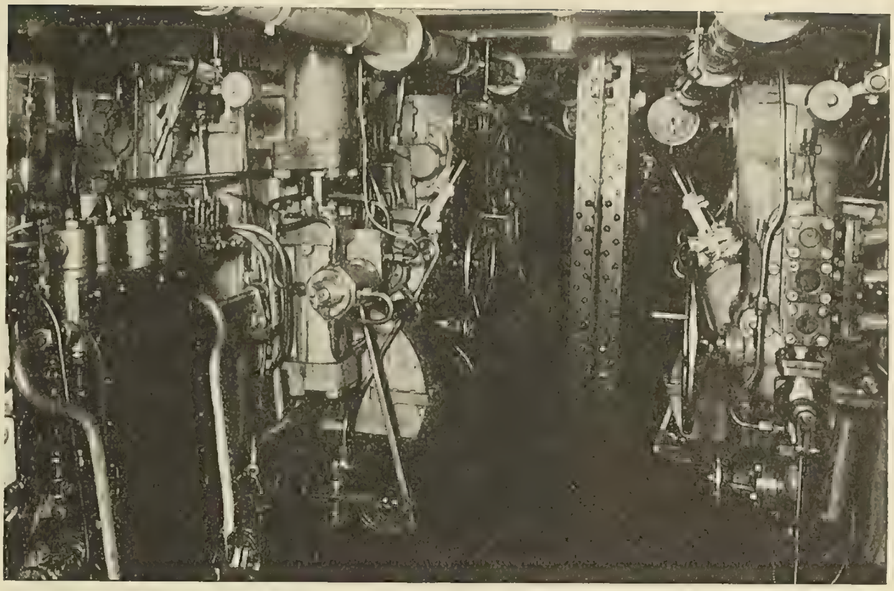
Orders continue to be placed on a large scale by the leading shipowners in Great Britain for motor vessels, mainly for the cargo carrying trade, and among the more important concerns which have recently adopted this policy are the Royal Mail Steam Packet Company, which has contracted for three 8,000-ton motor vessels with Workman Clark and Company, of Belfast, and The Pacific Steam Navigation Company, which has ordered a motor vessel of approximately the same size from Harland and Wolff. In all these vessels four cycle machinery of Harland and Wolff construction will be installed, and this firm, in order to cope with the vast amount of work in hand, has recently purchased a very big munition works in Glasgow to add to its already extensive factory designed and built purely for Diesel engine construction. It is hoped that when these extensions are in working order the machinery for about 40 motorships will be turned out annually.

New Bibby Motor Liner

The Bibby Line, one of the largest shipowning firms trading to the East, has ordered a second motorship similar to the vessel referred to recently in these notes, and the two sister ships will both be in commission within the course of the next few months. These vessels are inter-

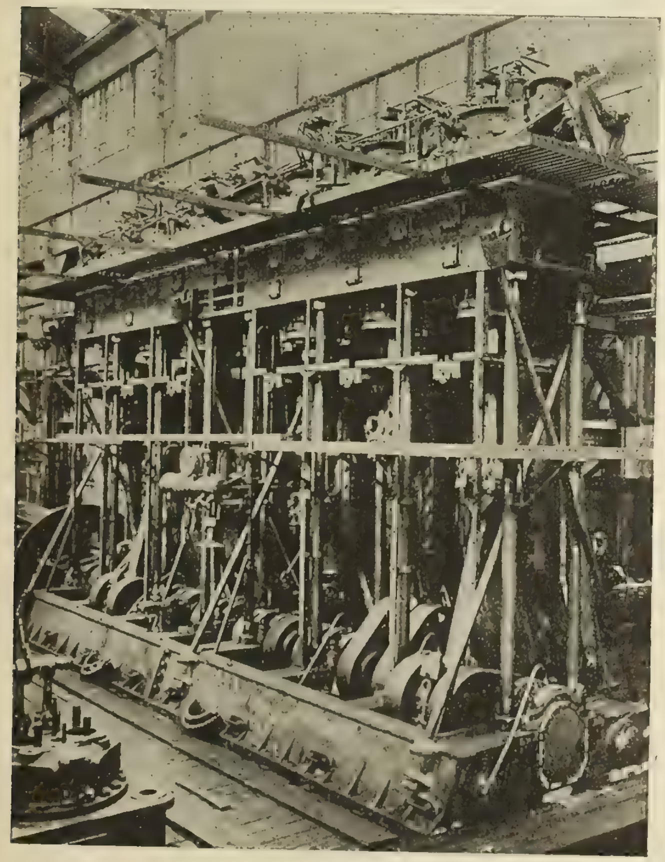
esting, as they are of approximately the same size as the 13,000-ton motorships built for the United States Shipping Board. They are 450 feet in length, with a beam of 57 feet, and carry rather more than 12,000 tons. The machinery is of exactly the same power as that installed in the United States Shipping Board vessel, comprising a couple of six cylinder engines developing 2,250 indicated horsepower, each at 115 revolutions per minute, with cylinder dimensions 740 millimeters bore and 1,150 millimeters stroke.

It appears that this class of vessel and engine is likely to become standard, as a large number of similar ships have recently been ordered by Continental shipowners for construction in Copenhagen by Burmeister and Wain. As in many of the latest vessels, electrical auxiliaries are employed throughout and the system adopted is interesting, comprising the installation of three 100-kilowatt Diesel driven electric generators. Bilge pumps, circulating water pumps, lubricating oil pumps, steering gear, winches and, in fact, every auxiliary on the ship is electrically operated, the only steam plant being a small auxiliary compressor to be employed in emergency. The boiler supplying the steam to this compressor is moreover utilized for heating the cabin, but for no other purpose.



Control Platform in the Engine Room of the New 10,000-Ton Motor Tanker *Narragansett*, Built by Vickers, Ltd., for the Anglo American Oil Company

Another motor vessel has just been completed in Holland for the Otto Thoresen Line named the *San Miguel*. This ship is of relatively small size, but is of interest from the fact that she is a single screw vessel, giving an indication of an increasing confidence felt by shipowners in the reliability of oil engines for ship propulsion. The motor, of which an illustration is given, has six cylinders and develops 1,400 indicated horsepower at 125 revolutions per minute, the cylinders being 560 millimeters bore and 1,000 millimeters stroke. It will be noticed that there are some points in difference between this motor and the type developed by the American licensees of the Werkspoor Company, of Amsterdam, who built the engine. The main feature of the motor is the method of supporting the cylinders by means of long steel columns with cross bracing, the cylinders being arranged in blocks of three, enclosed in each case by one water jacket. This engine is extremely popular with shipowners and there are about one dozen motorships now under construction in which Werkspoor motors ranging from 1,100 to 1,800 indicated horsepower are to be installed.



1,400 Indicated Horsepower Werkspoor Engine Installed in the Single Screw Motorship *San Miguel*

STANDARDIZED MOTORSHIPS FAVORED

The idea of standardization in motorship building has gained a great hold on European shipowners, and nearly all the leading motorship builders in Great Britain and on the Continent have orders for half a dozen motorships of exactly similar size and similar machinery. Messrs. Vickers, Ltd., of Barrow, for instance, have received contracts for six 10,000-ton motor tankers, of which the first, the *Narragansett*, recently started on her maiden voyage to New Orleans. As might be anticipated, the Vickers system of solid injection of fuel is employed in the machinery, which comprises two sets of 1,250 brake horsepower engines in each ship. They are of the ordinary four cycle type with cylinder diameters of 24½ inches and a stroke of 39 inches. Owing to the absence of the air compressor they are relatively short motors with a lower weight and a higher mechanical efficiency than engines adopting the ordinary blast injection system. The fuel is supplied to the fuel valve from four small vertical pumps, which are seen on the left of the illustration showing the control platform of the *Narragansett*. The fuel at a pressure of 4,000 pounds per square inch is taken

(*Concluded on page* 602.)

The Strainagraph and its Application to Concrete Ships*

BY FRANKLIN R. MC MILLAN†

While this article deals with the measurement of the stresses in the structure of a concrete ship during a launching, it is evident that the strainagraph may be just as efficiently used to determine the stresses in a steel ship not only during a launching but also when the vessel is in a seaway. In fact, Professor McMillan has conducted a test on the steel freighter Westboro while the vessel was crossing the Atlantic in which he obtained a continuous record of the water pressure and resultant stresses in the structure of the vessel by the use of pressure gages and strainagraphs.

THE strainagraph may be said to consist of two essentials, a lever system for multiplying the deformation due to stress and a moving chart upon which the multiplied strains are recorded. In the photographs, Figs. 1 and 2, these main features will be recognized readily. From these views also many of the details of the instrument will be understood.

In Fig. 1 the instrument is shown mounted on a piece of timber; this gives an idea of the general arrangement of a setting. The instrument itself is attached at one point, and the distance bar or plunger is attached at another. The distance bar is in contact with the lever system, so that any change of length between the points of attachment is transmitted to the lever system and recorded on the chart.

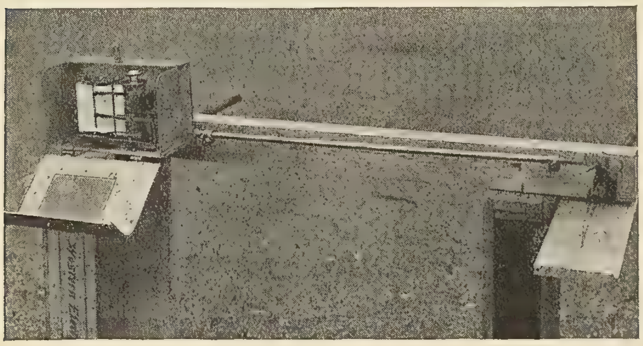


Fig. 1.—The Strainagraph Set Up as it Was on the Concrete Ship

In the larger view of Fig. 2 the details of the lever system can be made out. The large horizontal lever near the base of the instrument is fixed to a shaft, at the circumference of which a knife edge bearing receives the movements from the distance bar. The lever arm here is one-quarter inch, giving a multiplication of nine between this and the large lever. The balance of the multiplication, which is about 140 in all, is made up in the pen arm itself.

The device for receiving the movements from the distance bar cannot be seen in the photograph. This consists of a short plunger carried in a block entirely within the case and bearing against the knife edge mentioned above. The free end of this plunger is turned to a segment of a sphere, so that the distance bar, which has a square end, need not be in perfect alinement to insure proper contact.

It will be observed that the pen arm is pivoted at the extreme right to a movable link and near the center through a short link to a fixed support. This gives a true straight line motion to the mark'ng pen.

Attention is also called to the adjustable counterbalance on the large lever and to the slender coil spring between the right end of the lever and the pen arm. The lever system is perfectly balanced, so that the only resistance to be overcome is the slight friction in the bearings and the small tension in the spring.

The other features of the instrument can be seen in the photographs. The upper pen arm, which is operated by the magnet seen at the right, is used to synchronize the records from a number of instruments. The cylindrical piece supporting the magnet and pen also forms the support for the short link of the main pen arm and serves as a container for the feed roll.

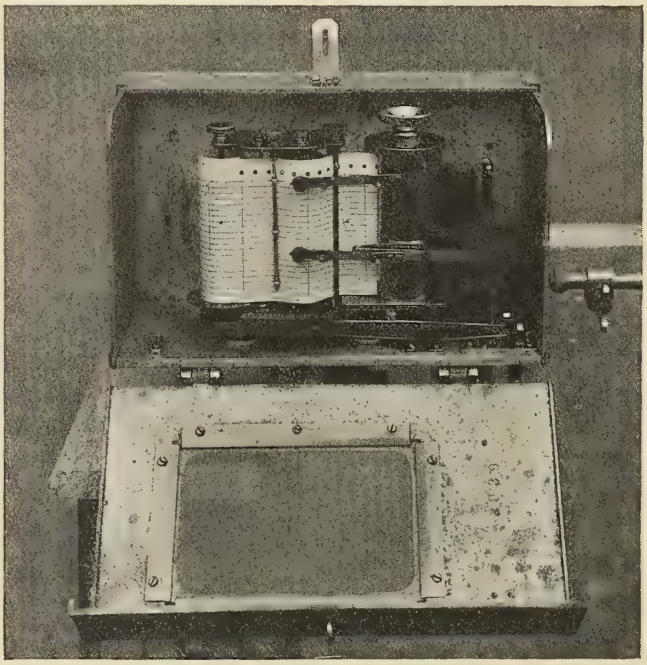


Fig. 2.—The Recording Mechanism of the Strainagraph

The paper is driven by a series of sprocket teeth set in the cylinder upon which the pen points travel. The holes punched in the paper to receive these teeth are clearly seen in both photographs. The re-wind roll at the extreme left is driven by a friction contact, so adjusted that the tension in the paper does not materially change as the spindle is filled.

The photographs in Figs. 1 and 2 were taken before the change was made from a clock to a motor drive for the chart. The clock mechanism is entirely concealed by the

* From a paper read before the American Concrete Institute.

† Formerly research engineer concrete ship division, United States Shipping Board, Emergency Fleet Corporation.

chart. With the motor drive a train of gears occupies the space at the back of the instrument and to the left of the re-wind spindle. This is driven by a coil spring belt, which passes through the base of the motor suspended below. The instrument, equipped with motor and gear train, weighs 20 pounds, which is a little less than when equipped with the clock movement.

The distance bar is adjustable at both ends, so that it can be accommodated readily to small variations in the gage line. When setting the instrument, the final adjustment is accomplished by the knurled nut at the instrument end, by which the pen can be brought to any position with a slow, steady motion. The fixed end of the distance bar

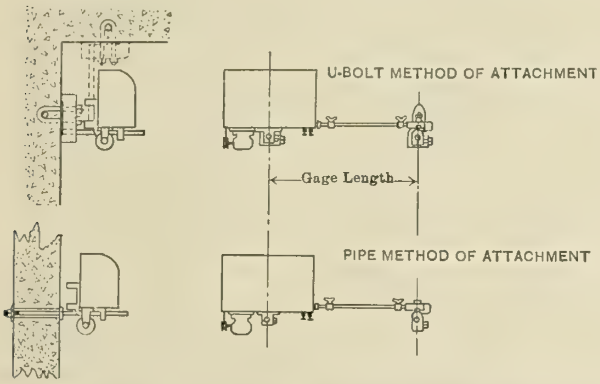


Fig. 3.—Method of Attaching the Strainagraph Used in the Steamship *Atlantus* Launching

is provided with a notch which engages a turned pin, also with a stiff looped spring which holds the pin firmly in the notch. The faces of the notch are tapered so that a width of only one-sixteenth inch bears against the pin; this arrangement permits of some sidewise adjustment for alinement.

The instrument is equipped with a clamp, not visible in the photographs, that grips a bar of ¾-inch diameter in either a vertical or horizontal position. In Fig. 1 the bar, to which the instrument is clamped, is seen projecting back of the timber. The turned pin at the fixed end of the distance bar is screwed into a small casting that grips a similar ¾-inch bar. The small casting is also tapped at the side to receive the turned pin, so that it can be adjusted to a vertical bar.

The device for attaching the instrument to the ship consists of a ¾-inch bar rigidly connected to the concrete. This connection has been accomplished to date by two methods, the U-bolt method and the pipe method, both of which are illustrated in Fig. 3. In the pipe method the ¾-inch bar passes through and is bolted to a pipe sleeve embedded in the concrete, while in the U-bolt method the ¾-inch bar is held by a cast iron wall block, which in turn is clamped to the concrete by the U-bolt itself. The latter is cast in place and is usually clamped around one of the reinforcing bars. The pipe sleeve method is preferable whenever it can be used, as it offers a more simple attachment for the instrument. This method can also be used in attaching an instrument to a structure already completed by simply drilling through the slab or beam. This was done in attaching the strainagraphs to the deck and keelsons of the *Faith*. In this test also a yoke attachment was used on some of the beams, but the other methods are preferable.

It will be observed that in either of these methods the ends of the gage line represent points on two planes, and the recorded movement gives the change in distance between these planes at the line of the plunger.

The motors which drive the record charts were designed to give approximately the same speed of travel to the charts of all the instruments at varying voltages, so that the speed can be varied alike in all the instruments from a central point. They are shunt wound motors operating at all voltages between 10 and 30 and give a speed to the charts varying from 5 to 13 inches per minute. They are connected in parallel to circuits from a storage battery, the voltage being regulated by cutting in the desired number of cells.

Operation of a Series of Instruments

In laying out the circuits on a ship, a system of trunk lines and branches is used, with rather heavy conductors, to avoid a large drop in voltage in the long lines. Care is also taken to have the circuits approximately balanced so that all instruments operate under the same voltage.

The magnets which operate the upper pens of the series of instruments are connected in parrallel to a telegraph relay instrument and a battery circuit. The primary circuit of the relay is connected through a circuit-closing clock, which gives two impulses at each minute and single impulses at each 10-second intervals. These impulses relayed to the instruments give offsets in the continuous line drawn by the magnet pens, from which the record of all the instruments can be compared for any instant of the test. A telegraph key is also connected in the primary circuit, by means of which extra impulses can be introduced to further identify the records or to record special events.

In the launching test of the *Atlantus*, 18 strainagraphs and 14 pressuregraphs were thus operated simultaneously, all controlled from a convenient central point. In the tests on the 8,800-ton steel ship *Westboro* in a recent transatlantic voyage, 23 strainagraphs and 12 pressuregraphs were operating at one time. In these tests over six hundred records were obtained, and throughout the operation was most satisfactory.

Strainagraph Records and Their Interpretation

A sample record from the strainagraph is shown in Fig. 4. This is a portion of a record from the *Faith* taken during a storm. The line drawn by the magnet pen near

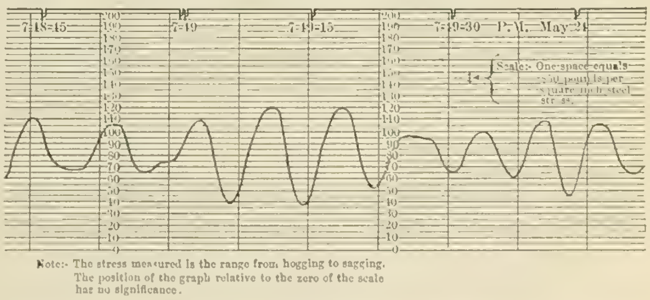


Fig. 4.—Specimen Strainagraph Record Taken on the *Faith* May 24, 1918

Instrument Located Amidships on a Longitudinal Deck Beam About Midway Between Hatches 2 and 3 and on a Line Along the Port Side of These Hatchways. The Pen When Traveling Upward Records Compression; When Traveling Downward Records Extension

the top of the chart will be recognized. It will be noticed that 15 seconds intervals are recorded here. In this test the identifying marks were made by closing the circuit with a telegraph key, as the circuit closing clock was not completed.

The strain record is the wavy line through the central portion of the chart. As noted under the chart, an upward travel of the pen indicates a compression or shortening of the gage length, and a downward travel indicates a tension or a lengthening.

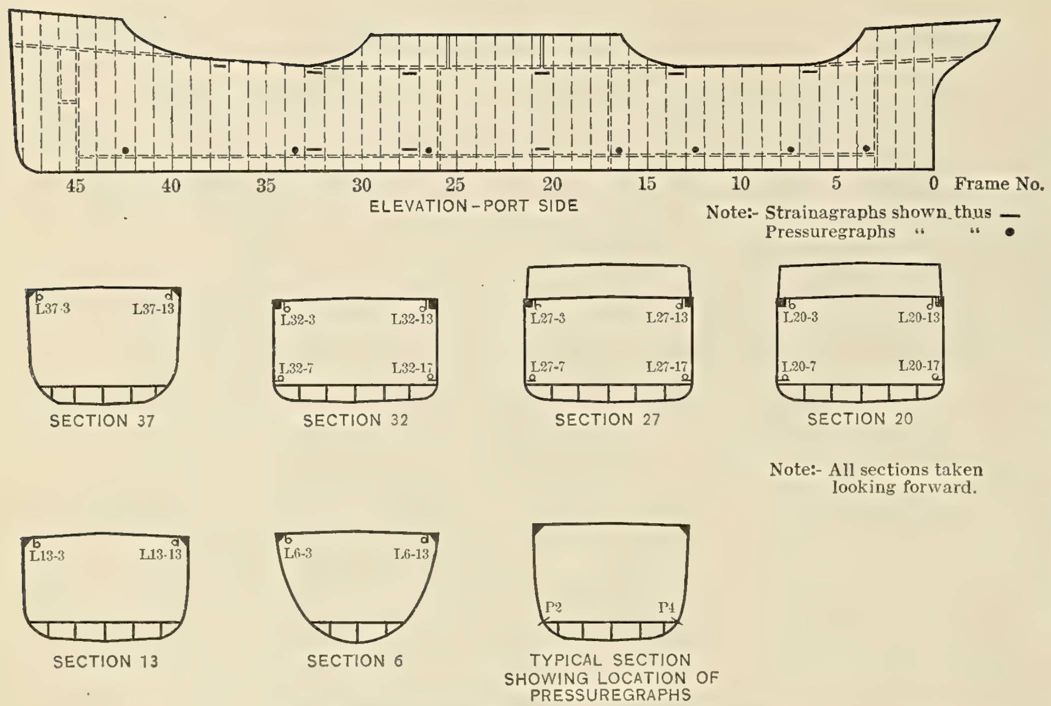


Fig. 5.—Location of Instruments on the *Atlantus*

It should be noted that the scale to which the chart is ruled is unimportant. That this is true will be apparent when it is explained that each instrument must be carefully calibrated, and unless each is provided with a chart of special ruling, a calibration factor or scale unit must be applied in making all reduction of data. The scale unit, therefore, takes care of the scale paper and a chart of any convenient ruling will serve.

On the record shown in the figure, the unit as determined by a calibration is noted. This is given for a 40-gage line and is expressed in terms of pounds per square inch steel stress for each 10 units shown on the printed chart. To obtain the change in stress between any two points, as, for example, for any one second or between any high point and the next low point of the curve, it is only necessary to read the paper scale for the two points and to multiply their difference by the scale unit. For example, the large change from top to bottom at about the quarter-minute point is reduced as follows:

Scale readings 120 and 37: difference = 83.
Stress 83 × 85 = 7,055 pounds per square inch.

The absence of a zero line for these measurements will have been noted from the foregoing explanation. When an instrument is attached to a ship while in motion, as is the case when shifting instruments from place to place at sea, the pen is constantly in motion and is brought to a central position on the chart before a set of records is started. For a test like the launching, the pen is brought to a convenient position on the chart and the charts run a few minutes before the ship is released. The horizontal line drawn by the pen before the ship is in motion becomes the zero line and its position on the chart can be read from the printed scale. Were it not for errors introduced by temperature changes and the possibility of the instrument being disturbed, it would be possible to attach an instrument to the ship when in quiet water and by a continuous record determine the change from still water to the extreme of a storm. The difficulties mentioned, however, together with the necessity of changing record charts, make this impractical.

Another point in connection with these records should be mentioned here. The recorded movements are deformations and not stresses, but it is found more convenient to express the deformation in terms of equivalent steel stress than in so many millionths of an inch. Thus a deformation in the steel of the magnitude shown by the record would represent a steel stress of a certain amount. For this scale a modulus of elasticity of the steel of 30,000,000 is assumed. For any other value of the modulus the correction can be made easily in the calculations.

Calibration

Calibration of the strainagraphs consists in determining the ratio of multiplication of the lever system. With this ratio and with the scale of the rulings on the paper known, what is called the instrument constant can be determined. The instrument constant is a figure which, when multi-

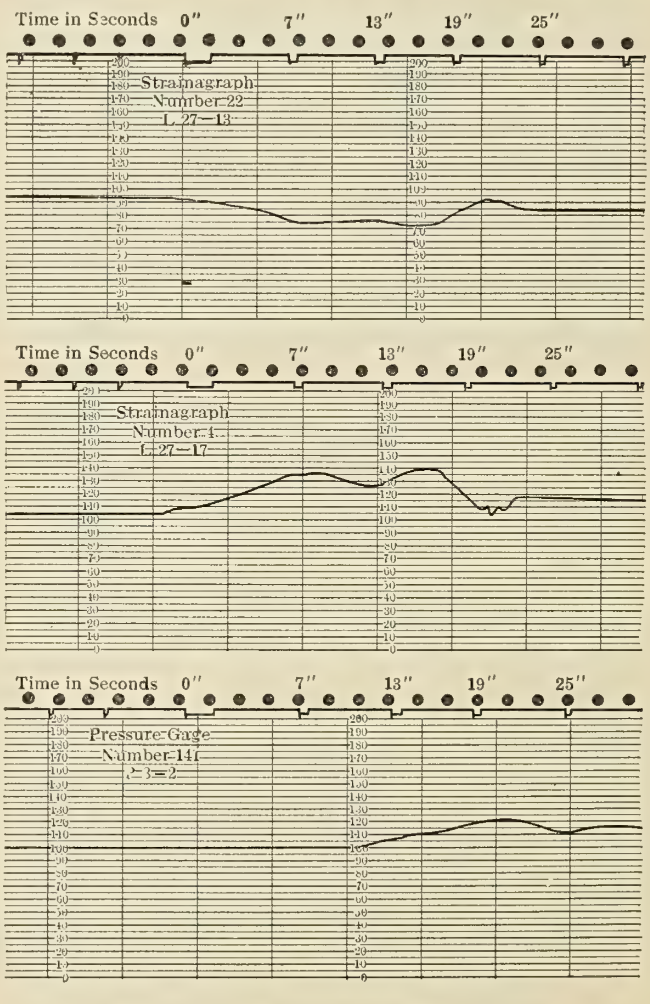


Fig. 6.—Specimen Records from the Strainagraph

plied by the modulus of elasticity and divided by the length of the gage line, gives the scale unit, or stress in pounds per square inch corresponding to one unit on the paper scale. It is obtained by dividing the length in inches of one unit on the paper scale by the ratio of multiplication. For the 25 instruments used in these tests the constant varies from 0.000110 to 0.000116.

The ratio of multiplication is determined with the instrument set up as when in service, but with the small casting in which the distance bar is pivoted clamped very lightly. An Ames gage is attached to the adjustable collar at the free end of the distance bar, so that the gage plunger bears against the strainagraph case. By slipping the lightly clamped casting through a slight angle, the pen is moved a small distance. This distance is read and the movement of the Ames gage is also noted. This gives the ratio between the movement of the pen and the true change of length in the gage line. This method of calibration has been found to be not only very convenient, but reliable and accurate as well.

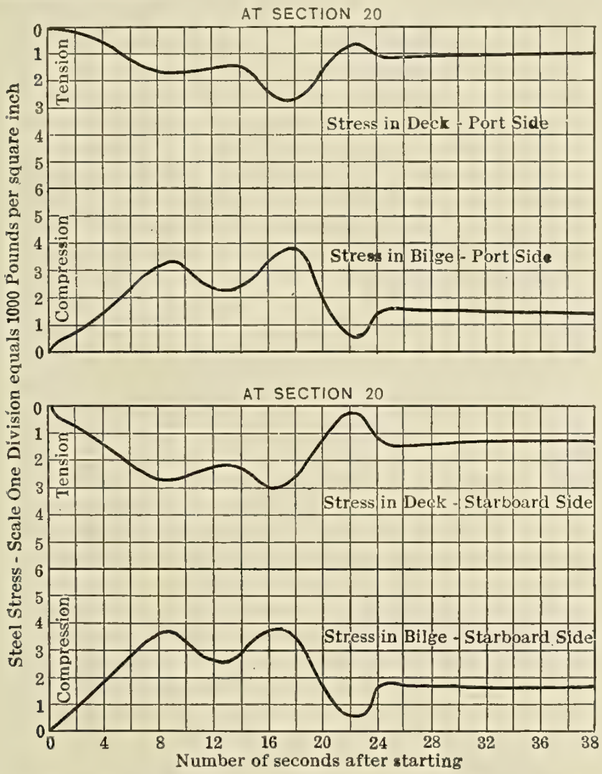


Fig. 7.—Longitudinal Stresses at *Atlantus* Launching

APPLICATION OF STRAINAGRAPH TO STUDY OF LAUNCHING STRESSES

The instrument and the interpretation of the records having been described, it remains now to show some of the results obtained from its use.

In the launching at Brunswick, Ga., of the *Atlantus,* the first reinforced concrete ship built under supervision of the Concrete Ship Section of the Emergency Fleet Corporation, the arrangement of instruments shown on the drawings of Fig. 5 was used. As this was an endwise launching, in which it was desired to obtain longitudinal stresses, the significance of the arrangement will be apparent.

Sample records for the strainagraphs at two points during this launching are shown in Fig. 6. It will be noted from the location number given on the records and from the key diagrams of Fig. 5 that these two instruments were located between frames 27 and 28, on the starboard side. The upper record is from the instrument at the deck and the second record from the instrument on the shell just above the inner bottom. The lower record shown in Fig. 6 is one of the pressuregraph records taken during this test.

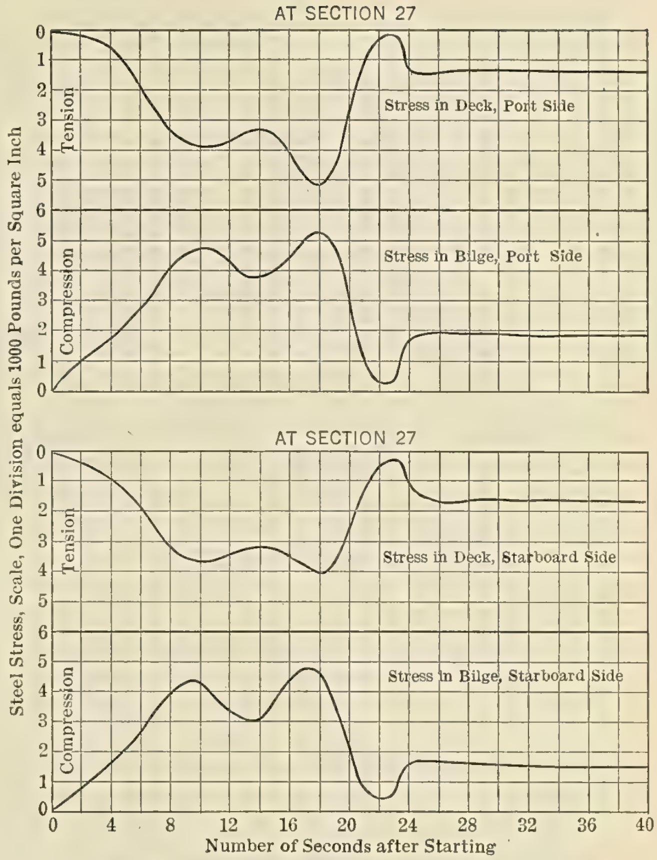


Fig. 8.—Longitudinal Stresses at *Atlantus* Launching

From the descriptions given previously, the meanings of these records will be clear. The straight portion of the line made by the marking pen at the left of the figure is the record made before the ship began to move. The stress at any instant subsequent to this is referred to this line as a zero. The record for the deck location will be seen to be tension throughout, and that for the lower instrument compression.

On Figs. 7, 8 and 9 are plotted the results from the strainagraphs at the three sections where the instruments were located at both deck and bottom. In preparing these curves the deformations have been reduced to equivalent steel stresses and have been corrected for the positions of the instruments to show the stresses at the extreme top and bottom. In making this correction, straight line variation of stress has been assumed.

RESULTS OF TEST

It is not the purpose of this paper to present a full discussion of the results of this launching, for the combined strain and pressure records provide data for a study too extensive to include here. Therefore, only the briefest discussion will be attempted. The pressure records will not be given, and only one set of results derived from them will be shown for the purpose of illustrating their use. These results are given in Fig. 10 and show the draft for four successive seconds, just before the bow passed off the ways. On this figure the drafts are plotted as ordinates downward from the base line. The full line shows the actual water surface as obtained from the records, and the dotted line shows the plane of the still water surface. On the outline of the ship at the top the

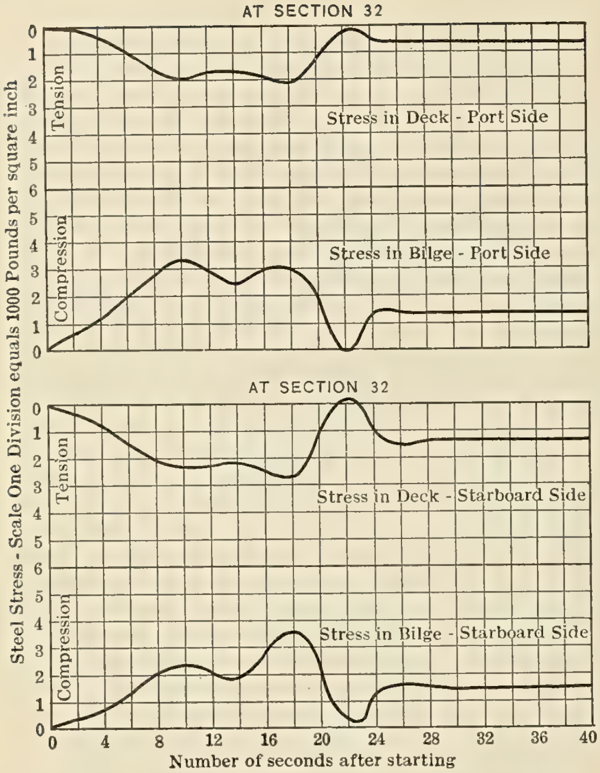


Fig. 9.—Longitudinal Stresses at *Atlantus* Launching

actual water surface for the nineteenth second is drawn to the same vertical scale as the ship. It will be noted that the slope of the dotted line, referred to the base line, and, expressed in the proper scale, gives the direction of travel of the ship relative to the water surface. From these and similar curves for other periods the buoyancy has been determined for any instant. The moments given in Fig. 14 were calculated from the buoyancies determined from these curves.

An examination of Figs. 7, 8 and 9 shows that hogging stresses (that is, tension in the deck) began to develop as soon as the hull started to move, and these increased until about the ninth second. Following this will be seen a partial return to a condition of no stress and then a further increase to about the eighteenth second. From the eighteenth to the twenty-second second there was a sharp decrease in the stresses to very nearly zero at all points and a quick return to the condition in which it remained in quiet water.

The stress during the first 12 or 15 seconds was due to a slight vertex in the ways, due to irregularities in construction, over which the hull had to pass. From the sixteenth second the stress was due to the hogging of the ship over the end of the ways. This reduced to almost no stress from the eighteenth to the twenty-second second as the buoyancy at the stern increased. From the twenty-fifth second to the end of the record the hogging stresses are due to the normal hogging moment in the hull.

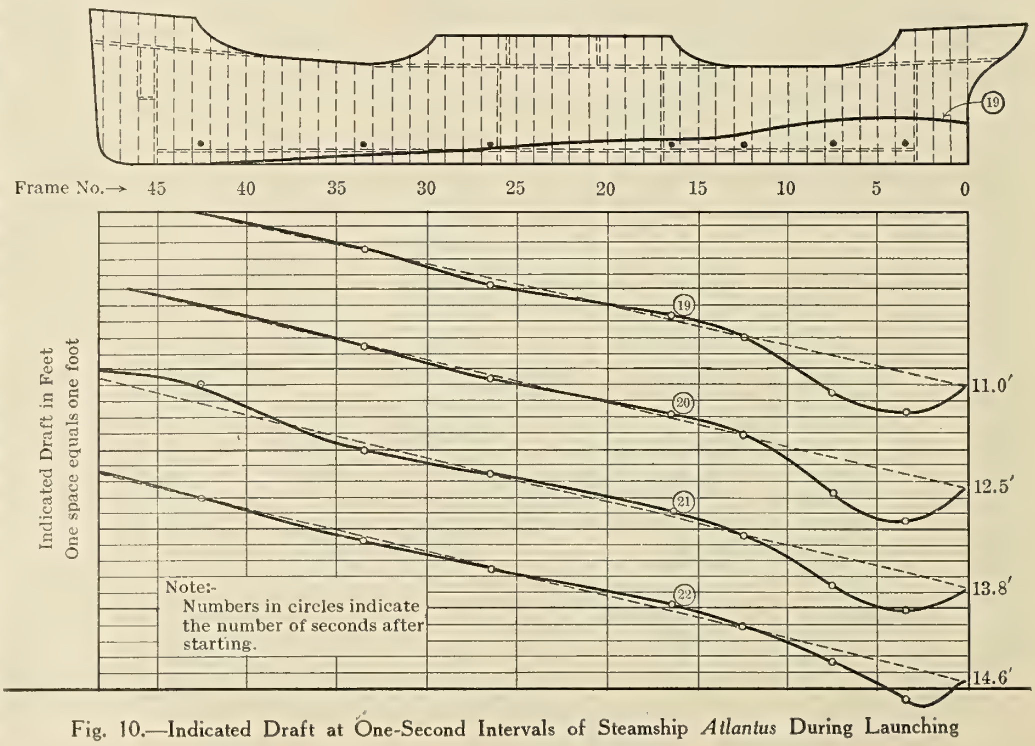


Fig. 10.—Indicated Draft at One-Second Intervals of Steamship *Atlantus* During Launching

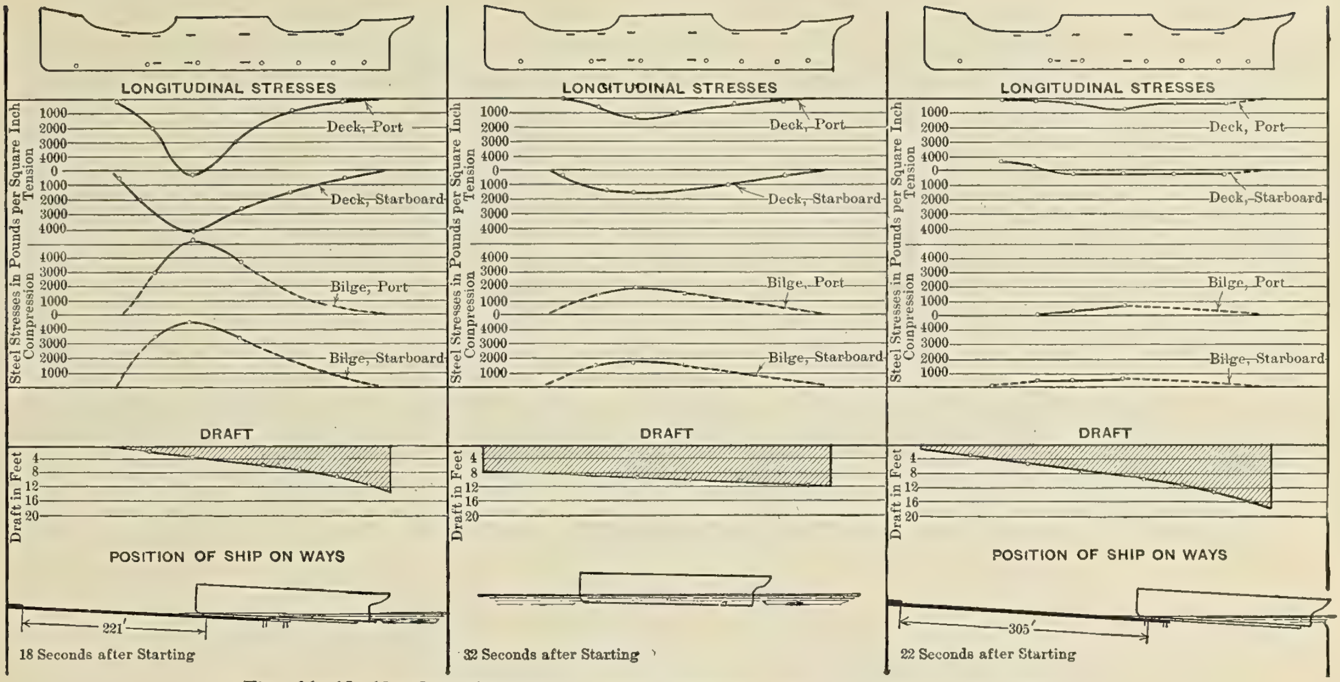
The variation in stress along the ship at the eighteenth second is shown in Fig. 11. The data for these curves were obtained from the curves of Figs. 7, 8 and 9, and similar curves for other points. This figure shows also the position of the ship on the ways and the observed drafts for that instant. Similar curves for the twenty-second and thirty-second seconds are shown in Figs. 12 and 13. These show respectively the conditions at the time of lowest stress and under the final hogging moments.

The most interesting feature of this test is the comparison of the resisting moment as determined from the strainagraph records with the applied moments as calculated from the observed drafts. This comparison is shown in Fig. 14 for the three sections where measurements were made at both top and bottom. The calculated moments were obtained by the usual calculations based on known weights and buoyancies.

Method of Calculation

In calculating the resisting moments from the strainagraph data the same assumptions were made as were used in the preparation of the design of the ship. These include those usual in the common theory of flexure and the further assumption that the bulwarks and bridge deck did not add to the resisting moment. It should be noted here that the bridge deck and bulwarks were cast separately from the hull and expansion joints were provided about 25 feet apart. All the indications from the data point to the reasonableness of these assumptions and until further data are obtained from the behavior of this ship at sea it seems fair to accept them.

These calculations for resisting moment were made for a beam of homogenous section, giving to the steel area a weight equal to the ratio of its modulus of elasticity to that of the concrete. Tests of 31 cylinder specimens from



Figs. 11, 12, 13.—Launching Data at Different Periods of the Launching of the *Atlantus*

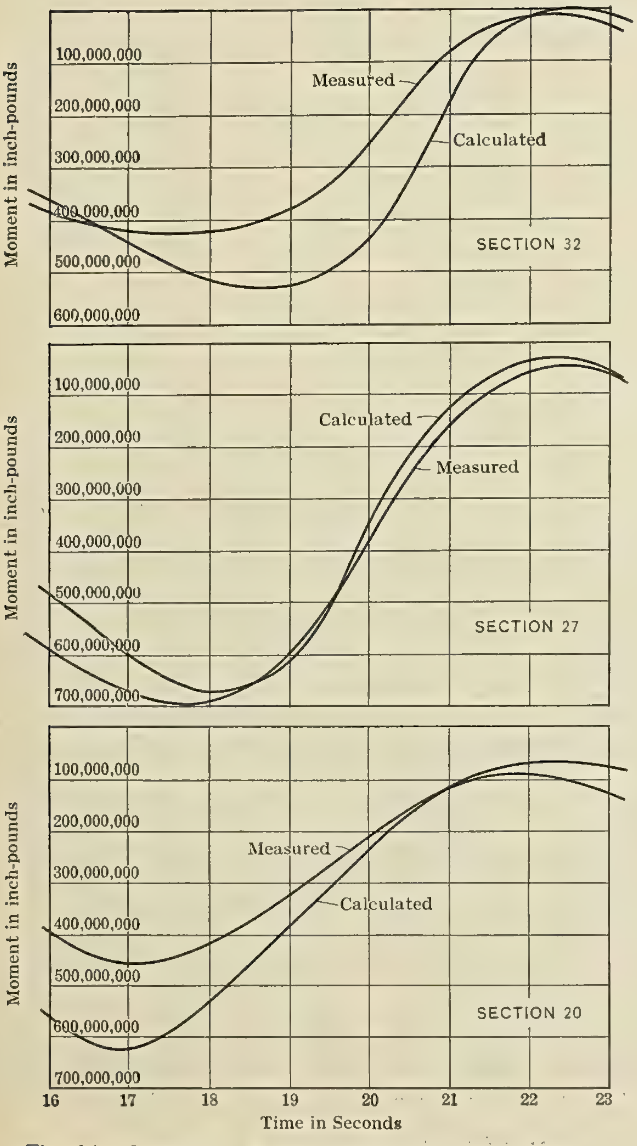


Fig. 14.—Comparison of Measured and Calculated Stresses on the *Atlantus* During Launching

various parts of the ship show an average value of 2,560,000 for the modulus of the concrete. A ratio of 12, therefore, was used on these calculations both for weighting the steel area and in reducing deformations in the concrete to equivalent stresses. The assumption as to the homogeniety of the section is considered fair, as the maximum tension did not exceed 500 pounds per square inch, and there was no evidence of tension cracks after the launching.

Referring now to Fig. 14, the real significance of the agreement between the two sets of curves will be appreciated. These curves represent the moments in the ship during the critical period of launching as determined by two independent sets of measurements of a widely different character. One set of curves gives the calculated applied moments based on water pressure observations, and the other set of curves gives the measured internal moment of resistance based on measured deformations in the hull.

It will be noted that in form the curves for each of the three sections agree remarkably well, also that the agreement in values for section 27 leaves nothing to be desired. In regard to section 20, it can be stated that the calculated moments for the sixteenth, seventeenth and possibly the eighteenth seconds are somewhat too high, for the arangement of pressure instruments was such that they did not record the full buoyancy at these periods. This would indicate better agreement than appears on the curve. In regard to section 32, it may be said that the curve of applied moments at the forward end of the hull cannot be determined as accurately as elsewhere because of the uncertainty in the distribution of the reaction from the ways.

In the light of these considerations it may be stated that the results are very satisfactory and show a high degree of reliability in the instruments. They also give a fair indication of what may be expected in future tests where it will be possible to eliminate some of the uncertainties encountered here.

The Ropner Shipbuilding & Repair Company (Stockton) Ltd., of Stockton-on-Tees, recently launched the single screw steel steamer *Atlantic City* for Cardiff owners. The vessel is 411 feet 6 inches long between perpendiculars, 54 feet 6 inches beam and 36 feet 4½ inches depth.

Fig. 1.—Waterfront of Winnisimmet Repair Yard

Winnisimmet Ship Repair Plant

Latest Addition to Ship Repair Facilities in Boston Harbor—Has Largest Railway Dry Dock in New England

BY E. P. B. RANKIN

BOSTON is once more to the fore in the all-important matter of port development, for there has just been completed at the Winnisimmet Ship Yard, Inc., at the extreme head of Boston Harbor where it makes into Chelsea Creek, not only the largest marine railway dry dock at this port but the largest in New England. It might further be added that the contract for its construction was executed in record time.

This latest port improvement marks the consummation of one of several features planned by the Winnisimmet company several months ago. It was soon after the organization of the company in June, 1918, that the old Winnisimmet ferry site was obtained and immediately the work of outlining plans for the plant was begun. These plans called for an enlargement of the site, remodelling of buildings, the construction of three piers, the building of a marine railway and the necessary power house and minor improvements and additions.

Work on the marine railway, the most important and necessary feature of the plans, was begun on May 26, 1919, requiring the excavation of 10,000 cubic yards of material by steam shovels on land, the driving of 700 oak piles as foundations for the four-track railway for the dry dock, the dredging of 51,147 cubic yards of material at the outboard end of the dock and the construction of retaining walls on either side of the railway, extending into the water. This part of the work represented 1,200 linear feet of retaining wall from 6 to 20 feet in height, which required 1,700 cubic yards of concrete in its construction and 700 cubic yards of granite blocks for facing.

The Railway Dry Dock

The cradle of the dry dock was constructed of long leaf yellow pine, with white oak keel blocks and spruce decking. As it stands completed, it has a hauling capacity of 4,000 tons. It measures 340 feet in length over the deck and

Fig. 2.—Sketch of Winnisimmet Ship Repair Plant

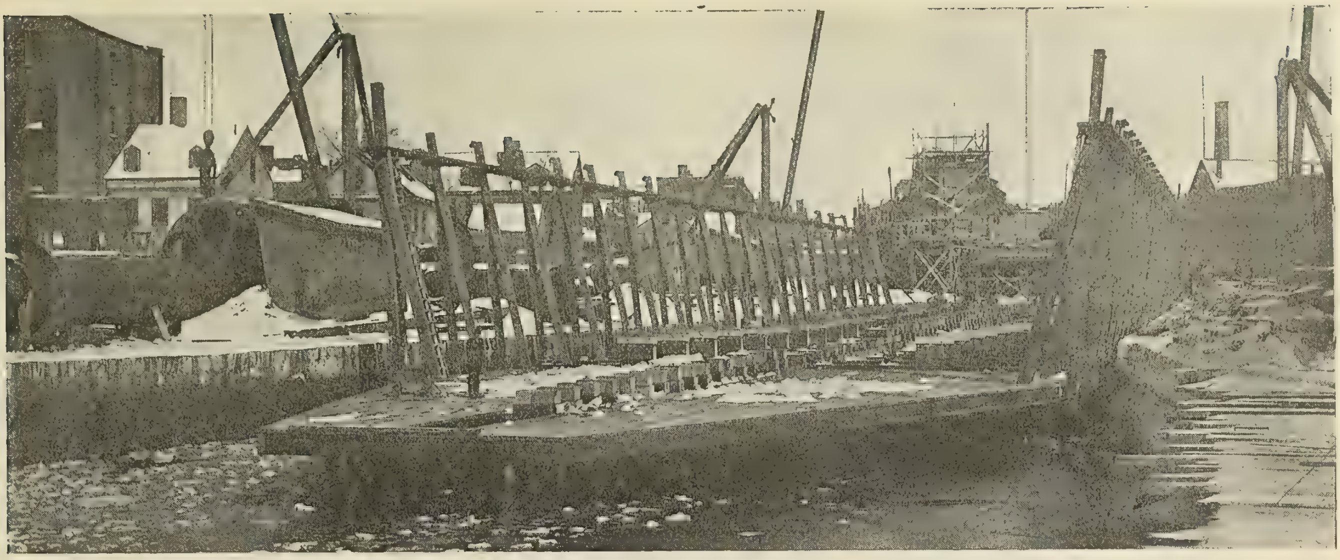


Fig. 3.—Railway Dry Dock, Winnisimmet Shipyard, Inc.; Capacity, 4,000 Tons

320 feet over the keel blocks and is 68 feet wide. There is a depth of 19 feet at mean high water over the keel blocks aft and 14 feet mean high water over the keel blocks forward. The deck is 2 feet 3 inches out of water at mean high water. The railway dry dock was designed and its construction was superintended by the Crandall Engineering Company, East Boston, Mass.

Equipment of the Power House

While all this work was advancing on the railway itself, the power house was also under construction. It is of brick, and when finished will be two stories high, with the exception of the space over the boilers. It will be 90 feet long and 50 feet wide and will have a 70-foot stack.

The power house is equipped with two boilers of the horizontal, multitubular type, 6½ feet in diameter and 22 feet long, of 125 horsepower, either being capable of handling the railway in case of necessity. The machinery is of a special type designed for this kind of a railway, the cylinders of the engine being 14½ inches by 18 inches. The largest gear (one casting) weighs 39,800 pounds, and the outfit is easily capable of handling the four hauling chains of 2⅝ inches which are used.

The number of employees at the new plant bids fair to reach the 1,000 mark before long. One of the main buildings is 75 feet long and 48 feet wide, and another 148 feet long and 58 feet wide, both built of brick, the former three stories and the latter two stories in height. In the former is housed the clerical force, drafting rooms, restaurant and storeroom, while the other is occupied by the

Fig. 4.—S. S. *Ransom B. Fuller* Undergoing Repairs in Winnisimmet Dry Dock

machine shop, tinsmith shop and joiners' shop. The blacksmith, boiler shop, riggers', calkers' and paint shops are in other smaller buildings.

Included in plans for the future is the erection of a thoroughly up-to-date boiler shop, while under way at the present time is the construction of two piers, one on either side of the new railway, No. 1 having just been completed, being 171 feet long and 20 feet wide. Work on No. 2 is progressing, and when finished it will be 330 feet long and 28 feet wide. Work on No. 3 has not yet been started, but when it is completed it will be 530 feet long and 35 feet wide. The lengths of all of the piers had to be governed by the pierhead line. All are of wooden pile construction.

Piers No. 2 and No. 3 will form a dock 110 feet wide for the mooring of steamers and other craft while undergoing repairs or while waiting their turns to go on the railway, and will be dredged to afford ample depth for the larger type of vessels. Other plans of a minor nature will be developed in the future.

Steel Ships Under Construction in American Shipyards for Private Account

PRIVATE orders in hand in American shipyards at the beginning of May, according to a statement just issued by the Atlantic Coast Shipbuilders' Association, aggregated 296 vessels of 1,404,698 gross tons. Foreign orders placed with American yards aggregate nearly 100,000 tons. The status of the various types of tonnage by monthly periods has been as follows:

1919	Tankers	Freighters	Other Types
October	74,437	235,523	37,383
November	214,940	295,493	40,281
December	369,084	400,556	35,507
1920			
January	476,742	470,197	30,549
February	588,565	620,567	47,441
March	722,549	561,455	53,441
April	745,140	623,917	35,641

Orders for tankers now in hand for various companies are as follows:

	No.	Gross Tons
Standard Oil Companies	23	181,410
Atlantic, Gulf & West Indies Company	14	116,100
Standard Transport Company	11	85,380
Union Oil Company	6	47,800
Sinclair Navigation Company	8	48,800
Pan-American Petroleum Company	6	36,571
Texas Company	4	23,600
Vacuum Oil Company	3	19,650
Anglo-Mexican Oil Company	4	21,000
Gulf Refining Company	3	18,900
Baltimore Dry Dock & Shipbuilding Company	2	12,000
General Petroleum Company	3	21,500
Ore Steamship Company	1	13,500
International Petroleum Company	1	13,500
W. A. Harriman & Company	2	12,500
New York Shipbuilding Corporation	2	12,200
Southern Pacific Company	1	12,000
French Owners	6	8,226
Owners Not Given	1	9,100
Societe Anonyme d'Armement	1	8,000
W. R. Grace & Company	1	7,753
Sun Company	1	6,800
American Sugar Refining Company	1	4,200
Galena Signal Oil Company	1	2,500
Tidewater Oil Company	1	1,200
Nyack Shipbuilding Company	1	950
TOTAL	108	745,140

New orders reported during April were as follows:

Freighters

Baltimore Dry Dock & Ship Building Company, 1 of 5,600 tons for builders' account.

Wm. Cramp & Sons, 1 of 2,000 tons for the Peninsula & Occidental Steamship Company.

J. F. Duthie, 2 of 1,500 tons each for the Coastwise Steamship Company.

Manitowoc Shipbuilding Company, 3 of 2,712 tons each for builders' account.

McDougall-Duluth Company, 4 of 2,338 tons each for the Sugar Products Company.

Merchant Shipbuilding Corporation, 2 of 7,500 tons each for the American-Hawaiian Company.

Tankers

Bethlehem Shipbuilding Corporation, Harlan plant, 2 of 4,500 tons each for the Sinclair Navigation Company; San Francisco plant, 1 of 8,650 tons for the Standard Oil Company of California.

Moore Shipbuilding Company, 1 of 12,000 tons for the Southern Pacific Company.

Skinner & Eddy, 1 of 9,100 tons, owner not given.

Union Construction Company, 1 of 7,000 tons for the General Petroleum Company; 1 of 1,650 tons for the Standard Oil Company of California.

Other Types

Bethlehem Shipbuilding Corporation, Moore plant, 2 refrigerator steamers of 1,400 tons each for the National Products Company.

Downey Shipbuilding Corporation, 1 oil carrier of 500 tons for the Mexican Petroleum Company.

Federal Shipbuilding Company, Kearney, N. J., plant, 4 barges of 450 tons each for the Mexican Petroleum Company; 4 barges of 500 tons each for the Sinclair Navigation Company.

The following table, compiled by the Atlantic Coast Shipbuilders Association, shows the volume of tonnage building for private account:

STEEL VESSELS UNDER CONSTRUCTION IN AMERICAN SHIPYARDS FOR PRIVATE ACCOUNT

Builders	Owners	Type	Gross Tonnage	No.	Total Tonnage
Alabama & New Orleans Transportation Company	Pan-American Petroleum & Transportation Company	Tanker*	1,371	1	1,371
American Bridge Company	Missouri Portland Cement Company	Barge x	300	3	900
American Shipbuilding Company	Builders	Freighter*	2,338	10	23,380
American Shipbuilding Company	Builders	Freighter†	7,700	4	30,800
Baltimore Dry Dock & Shipbuilding Company	Builders	Tanker†	6,000	2	12,000
Baltimore Dry Dock & Shipbuilding Company	Builders	Freighter*	4,311	2	8,622
Bath Iron Works	Crowell & Thurlow	Freighter*	5,600	1	5,600
Bayles Shipbuilding Company	Nyack Shipbuilding Company	Tanker†	950	1	950
Bethlehem Shipbuilding Company:					
Fore River	Atlantic, Gulf & West Indies Company	Tanker*	8,900	1	8,900
Fore River	Ore Steamship Company	Ore-Carrier†	7,150	1	7,150
Fore River	Sinclair Navigation Company	Tanker*	6,600	2	13,200
Fore River	Standard Transportation Company	Tanker*†	7,794	2	15,588
Fore River	Standard Transportation Company	Tanker*	8,900	2	17,800

STEEL VESSELS UNDER CONSTRUCTION IN AMERICAN SHIPYARDS FOR PRIVATE ACCOUNT—CONTINUED

BUILDERS	OWNERS	TYPE	GROSS TONNAGE	NO.	TOTAL TONNAGE
Bethlehem Shipbuilding Company:					
Harlan Plant	Sinclair Navigation Company	Tanker*†	6,600	2	13,200
Harlan Plant	Sinclair Navigation Company	Tanker†	4,500	2	9,000
Moore Plant	National Products Company	Refriger-ated*	1,400	2	2,800
Sparrows Point	Ore Steamship Company	Tanker†	13,500	1	13,500
Sparrows Point	International Petroleum Company	Tanker†	13,500	1	13,500
Sparrows Point	Atlantic, Gulf & West Indies Company	Tanker*	7,500	1	7,500
Sparrows Point	Atlantic, Gulf & West Indies Company	Tanker†	7,800	2	15,600
Sparrows Point	Standard Transport Company	Tanker†	6,900	1	6,900
Sparrows Point	Standard Transport Company	Tanker*	7,500	1	7,500
Sparrows Point	Standard Transport Company	Tanker*	7,150	1	7,150
Sparrows Point	Vacuum Oil Company	Tanker*	7,150	1	7,150
San Francisco	General Petroleum Company	Tanker*	7,500	1	7,500
San Francisco	Pan-American Petroleum & Transportation Company	Tanker*†	7,060	3	21,800
San Francisco	Standard Oil of California	Tanker†	7,060	1	7,060
San Francisco	Standard Oil of California	Tanker†	8,650	1	8,650
San Francisco	Standard Transport Company	Tanker†	7,060	1	7,060
San Francisco	Standard Oil of New York	Tanker*	7,500	1	7,500
Brunswick Marine Corporation	R. L. Smith	Barge*	1,250	1	1,250
Clinton Shipbuilding & Repair Company	Baldwin Locomotive Works	Lighter x	1,600	1	1,250
Clinton Shipbuilding & Repair Company	Atlantic Refining Oil Company	Oil Barge x	600	2	1,200
Clinton Shipbuilding & Repair Company	Union Petroleum Company	Oil Barge x	326	1	326
Clinton Shipbuilding & Repair Company	Union Petroleum Company	Oil Barge	1,200	1	1,200
Clinton Shipbuilding & Repair Company	Union Petroleum Company	Barge x	326	1	326
Cramp & Sons	Florida & East Coast Ry	Freighter x	2,406	1	2,406
Cramp & Sons	Peninsula & Occidental Steamship Company	Pass. and Cargo†	2,000	1	2,000
Oscar Daniels Company	Standard Oil Company	Tanker*	7,800	2	15,600
J. F. Duthie	Coastwise Steamship Company	Freighter†	1,500	2	3,000
Downey Shipbuilding Corporation	Southern Pacific Company	Freighter x	4,000	3	12,000
Downey Shipbuilding Corporation	Mexican Petroleum Company	Oil-Carrier	500	1	500
Federal Shipbuilding Company:					
Kearney, N. J.	Freeport Sulphur Company	Freighter†	4,127	2	8,254
Kearney, N. J.	Sinclair Navigation Company	Barge*	500	4	2,000
Kearney, N. J.	Standard Oil Company	Tanker*	10,000	5	50,000
Kearney, N. J.	Mexican Petroleum Company	Barge*	450	4	1,800
Kearney, N. J.	United States Steel Corporation	Freighter†	6,000	10	60,000
Chickasaw, Ala	Builders	Freighter*	6,869	4	27,476
Chickasaw, Ala	United States Steel Corporation	Freighter†	6,000	10	60,000
George A. Fuller Company	Builders	Freighter*	6,527	4	26,108
Greenpoint Shipbuilding Company	Bay State Fisheries Company	Trawler†	292	2	584
International Shipbuilding Company	J. A. Bandi	Freighter*	4,200	8	25,600
Johnson Iron Works	Cortez Oil Corporation	Oil Barge†	200	1	200
Kyle & Purdy	East Coast Fisheries Company	Trawler*	355	2	710
Long Beach Shipbuilding Company	Standard Oil of California	Tanker†	2,100	1	2,100
Long Beach Shipbuilding Company	California Mexico Shipbuilding Company	Freighter x	1,150	1	1,150
Long Beach Shipbuilding Company	Domingo-Nazabel Company	Freighter x	1,200	1	1,200
Manitowoc Shipbuilding Company	Atlantic Fruit Company	Fruit-Steamer*	2,000	2	4,000
Manitowoc Shipbuilding Company	Builders	Freighter*	2,712	3	8,136
McDougall-Duluth Company	Sugar Products Company	Freighter	2,338	5	11,690
Merchant Shipbuilding Corporation	Union Oil of Delaware	Tanker*	6,250	2	12,500
Merchant Shipbuilding Corporation	American-Hawaiian Steamship Company	Freighter*	7,500	2	15,000
Merchant Shipbuilding Corporation	Shawmut Steamship Company	Freighter*	7,300	2	14,600
Merchant Shipbuilding Corporation	W. A. Harriman & Company	Tanker*	6,250	2	12,500
Moore Shipbuilding Company	Matson Navigation Company	Freighter*†	9,500	2	19,000
Moore Shipbuilding Company	Standard Oil Company of California	Tanker†	3,250	1	3,250
Moore Shipbuilding Company	Standard Oil of New Jersey	Tanker†	7,000	3	21,000
Moore Shipbuilding Company	Vacuum Oil Company	Tanker*	6,250	2	12,500
Moore Shipbuilding Company	Southern Pacific Company	Tanker x	12,000	1	12,000
National Shipbuilding Company	French Owners	Tanker*	1,371	6	8,226
National Shipbuilding Company	Cuyamel Fruit Company	Fruit-Steamer x	250	3	750
Newburgh Shipyards, Incorporated	Cuyamel Fruit Company	Freighter*	3,000	2	6,000
Newburgh Shipyards, Incorporated	Union Sulphur Company	Freighter*	4,700	2	9,400
New Jersey Dry Dock Company	East Coast Fisheries Company	Trawler*	355	2	710
Newport News Shipbuilding Company	Atlantic, Gulf & West Indies Company	Tanker†	10,600	2	21,200
Newport News Shipbuilding Company	Standard Oil of New Jersey	Tanker*	13,500	2	27,000
New York Shipbuilding Corporation	W. R. Grace & Company	Tanker*	7,753	1	7,753
New York Shipbuilding Corporation	Builders	Tanker*	6,100	2	12,200
New York Shipbuilding Corporation	Standard Transport Company	Tanker*	7,794	3	23,382
Pusey & Jones Company	Eastern Steamship Company	Freighter x	2,700	1	2,700
Pusey & Jones Company	Not Given	Tanker*	9,100	1	9,100
Southwestern Shipbuilding Company	Builders	Freighter*†	6,100	1	6,100
Southwestern Shipbuilding Company	Union Oil of California	Tanker*†	8,650	2	17,300
Spedden Shipbuilding Company	Standard Oil Company	Oil Barge†	995	1	995
Standard Shipbuilding Corporation	Cuyamel Fruit Company	Fruit-Steamer*	1,500	2	3,000
Standard Shipbuilding Corporation	Anglo-Mexican Oil Company	Tanker*	5,250	4	21,000
G. M. Standifer Construction Company	Green Star Line	Freighter*	6,165	5	30,825
G. M. Standifer Construction Company	Standard Oil of New Jersey	Tanker*	8,000	3	24,000
Staten Island Shipbuilding Company	Galena Signal Oil Company	Tanker*	2,500	1	2,500
Staten Island Shipbuilding Company	American Sugar Refining Company	Tanker†	4,200	1	4,200
Staten Island Shipbuilding Company	Standard Oil of New York	Barge x	420	6	2,520
Staten Island Shipbuilding Company	Standard Oil of New York	Barge x	450	1	450
Staten Island Shipbuilding Company	Tidewater Oil Company	Tanker x	1,200	1	1,200
Submarine Boat Corporation	Builders	Freighter*†	3,545	32	113,440
Sun Shipbuilding Company	Atlantic, Gulf & West Indies Company	Tanker†	6,800	1	6,800
Sun Shipbuilding Company	Atlantic, Gulf & West Indies Company	Tanker*	9,000	4	36,000
Sun Shipbuilding Company	Atlantic, Gulf & West Indies Company	Tanker*	6,700	3	20,100
Sun Shipbuilding Company	Gulf Refining Company	Tanker*	6,700	1	6,700
Sun Shipbuilding Company	Pan-American Petroleum & Transportation Company	Tanker*	5,700	2	13,400
Sun Shipbuilding Company	Rotterdamsche Lloyd	Freighter*	7,700	1	7,700
Sun Shipbuilding Company	Sinclair Navigation Company	Tanker*	6,700	2	13,400
Sun Shipbuilding Company	Standard Oil of New Jersey	Tanker*	6,800	2	13,600
Sun Shipbuilding Company	Sun Company	Tanker*†	6,800	1	6,800
Sun Shipbuilding Company	Union Oil Company	Tanker*	9,000	2	18,000
Sun Shipbuilding Company	Societe Anonyme d'Orient d'Industrie	Tanker x	8,000	1	8,000
Tank Steamship Corporation	Southern Oil & Transportation Company	Oil Barge*	835	2	1,670
Tank Steamship Corporation	Southern Oil & Transportation Company	Oil Barge*	775	2	1,550
Texas Company	Builders	Tanker*	3,500	1	3,500
Texas Company	Builders	Tanker x	6,700	3	20,100
Todd Shipyards Corporation	Sinclair Navigation Company	Oil Barge*	1,800	1	1,800
Todd Shipyard Corporation	Donald Steamship Company	Fruit-Steamer*	1,400	2	2,800
Todd Dry Dock & Construction Company	Stock	Freighter*†	4,600	2	9,200
Toledo Shipbuilding Company	Not Given	Freighter*	2,560	3	7,680
Union Shipbuilding Company	Aluminum Company of America	Freighter*	3,100	2	6,200
Union Shipbuilding Company	Builders	Freighter*†	7,150	2	14,300
Union Shipbuilding Company	Gulf Refining Company	Tanker*	6,100	2	12,200
Union Construction Company	General Petroleum Company	Tanker*†	7,000	1	7,000
Union Construction Company	General Petroleum Company	Tanker†	7,000	1	7,000
Union Construction Company	Standard Oil of California	Tanker†	1,650	1	1,650
Virginia Shipbuilding Corporation	United States Steamship Company	Freighter*†	6,200	6	37,200

Total building: 296 ships, aggregating 1,404,698 gross tons

NOTE: † Classified by American Bureau of Shipping. * Classified by Lloyd's Register of Shipping. x Reported by United States Bureau of Navigation.

Freight Handling at Marine Terminals

Modern Methods Used in Loading and Discharging Vessels at Boston Army Supply Base—Mechanical Equipment Operated by Electricity

BY A. K. WEST*

INDUSTRY is appreciating more every day the truth of the axiom that efficiency increases in direct proportion to the extent that hand labor and haphazard methods of handling material are replaced by machines, the more automatic in principle the better. In marine terminals, where this principle would demonstrate its value to a great degree, there has apparently been no concerted effort to replace time-honored, expensive and casual methods that have nothing to recommend them but their venerability with modern mechanical and efficient means of handling of freight.

The result is that at most of such terminals the congestion both on the piers and in the warehouses and freight yards is tremendous; and the costs of loading and unloading—in fact, of all the necessary handling—have soared until it costs as much to load a barrel into a car at Chicago and unload it at New York as it does to transport it between the two cities. With the inevitable increase in production, unless something is done to better the terminal conditions at our large ports they are going to be very congested, and the commerce of the country will sustain losses that can be figured only in millions of dollars.

There are two remedies for this state of affairs, which, if properly considered and intelligently applied, would greatly relieve, if not altogether eliminate, such conditions. One is the proper layout and construction of wharves, storage centers and railroad facilities so that they would be mutually accessible for the handling and disposal of freight, and the other is the installation of mechanical handling devices for moving this freight, replacing manual methods.

In discussing such mechanical methods, it should be borne in mind that the requirements of the situation will be flexibility, compactness and accurate, reliable operation. These requirements are most efficiently met by handling machinery which has electricity for motive power, such as cranes, deck winches, tractors and similar devices. This is true for various easily explained reasons. One is that piers being badly congested under the best of cir-

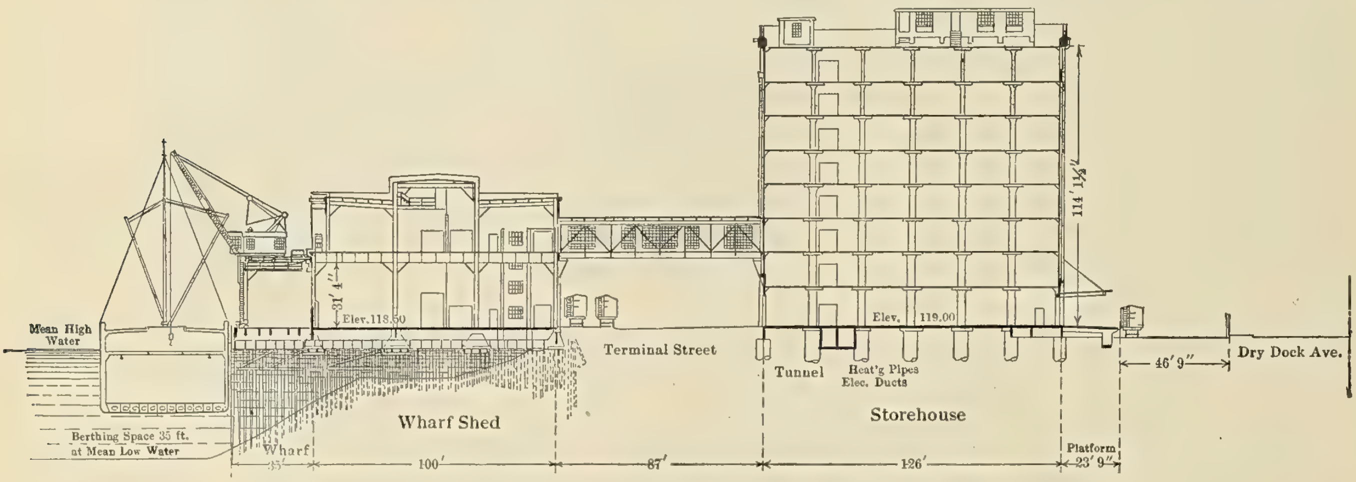


Fig. 1.—Cross Section of Storehouse and Wharf Shed, Boston Army Supply Base

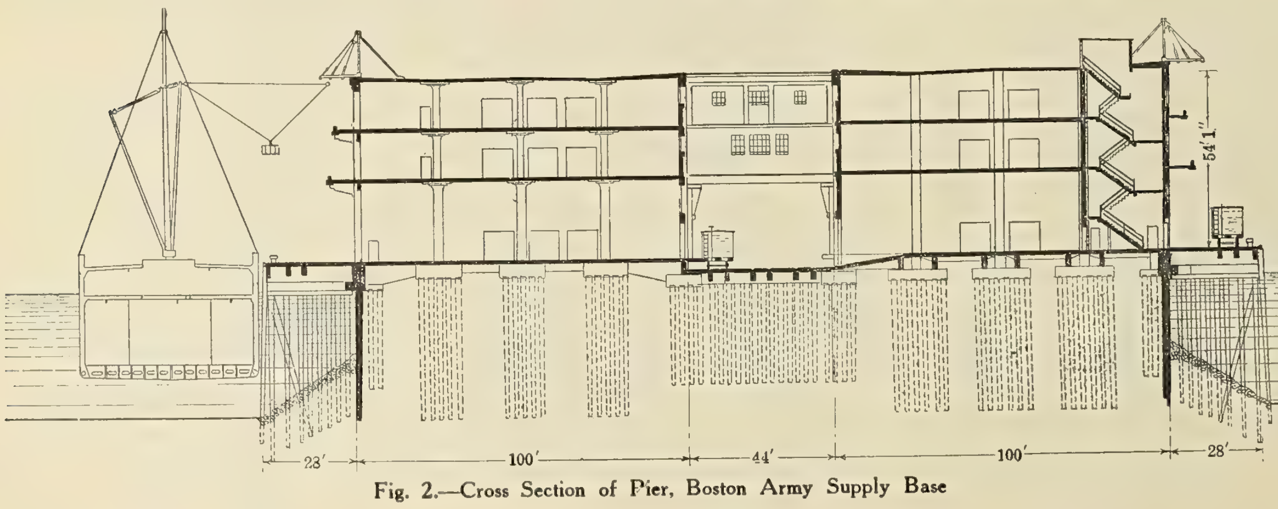


Fig. 2.—Cross Section of Pier, Boston Army Supply Base

* General Electric Company, Schenectady, N. Y.

cumstances, the mass of pipes, valves, etc., that are necessary for steam operated machinery would make confusion worse confounded, to say nothing of increasing the risk of fires and accidents. Furthermore, the characteristics of these devices—that is, the weight and the rigid method of supplying their motive power—demand that they be stationary. Lastly, they require constant attendance by trained operators, they are wasteful of power, and the control is none too good. As for the manual method of handling freight, whether about the warehouses or in loading and unloading the ships or cars, its disadvantages, costliness and inefficiency need not be stressed—they are too obvious.

Electric motive power, as applied to the various phases of freight handling, does away with these disadvantageous features to a considerable extent. The wires that supply the necessary energy can be placed anywhere that is convenient without taking up a great deal of room, and the apparatus itself is comparatively light, without sacrificing its rugged construction, and easily portable.

Thus two things are eliminated at once—danger from fires and the unwieldy character of the apparatus. The remote control feature of electric apparatus is another thing that gives it great value for this sort of work, as does the fact that when it is not working no energy is being lost. Electric motors have been successfully applied to almost every type of mechanical handling device, from those used in unloading the ships to devices for piling bags, etc., in the storage buildings.

The Boston Army Supply Base

The Boston Army Supply Base, built by the government to handle supplies for the American Expeditionary Forces, but capable of adaption to commercial uses later, is one of the nearest approximations to the ideal marine terminal existing, not only as regards the construction and layout of the various buildings but in the modern character of the handling apparatus installed.

What is known as the Army Section consists of a wharf shed of two stories, the floor area being 320,000 square feet, an eight-story warehouse, parallel and connected to the second floor of the wharf shed by bridges, having a total floor area of 1,651,000 square feet. Between these two buildings are railroad tracks, which permit the spotting of cars at the doors, and a roadway for trucks. The waterside landing platform is three-quarters of a mile long, extending beyond the buildings in both directions, and carries two railroad tracks. At one end of the wharf shed this platform is spanned by four elec-

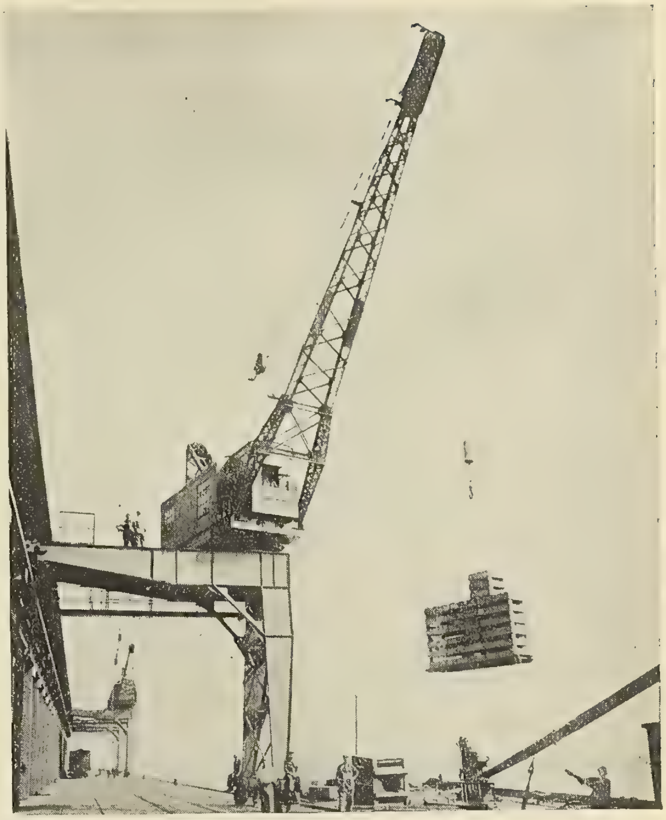


Fig. 4.—Portal Bridge Type Dock Crane at Boston Army Supply Base in Operation

tric cranes, which handle freight either to or from the landing platform or the gallery of the second floor. There are also a number of portable electric winches, which can be used on the platform if all the cranes should be busy.

The requirements of the internal transportation system of such a terminal are that it should permit the rapid movement of various types and classes of packages from the storage to the ship and vice versa with the minimum amount of hand labor. The various units must be easily controlled, occupy the least space possible and be so arranged that the breakdown of any one unit would not tie up or impede the functioning of the whole system.

Many types of apparatus were considered, but it was decided that these requirements would be most efficiently met by the system installed, which is almost entirely electrical in character and consists, roughly, of elevators in

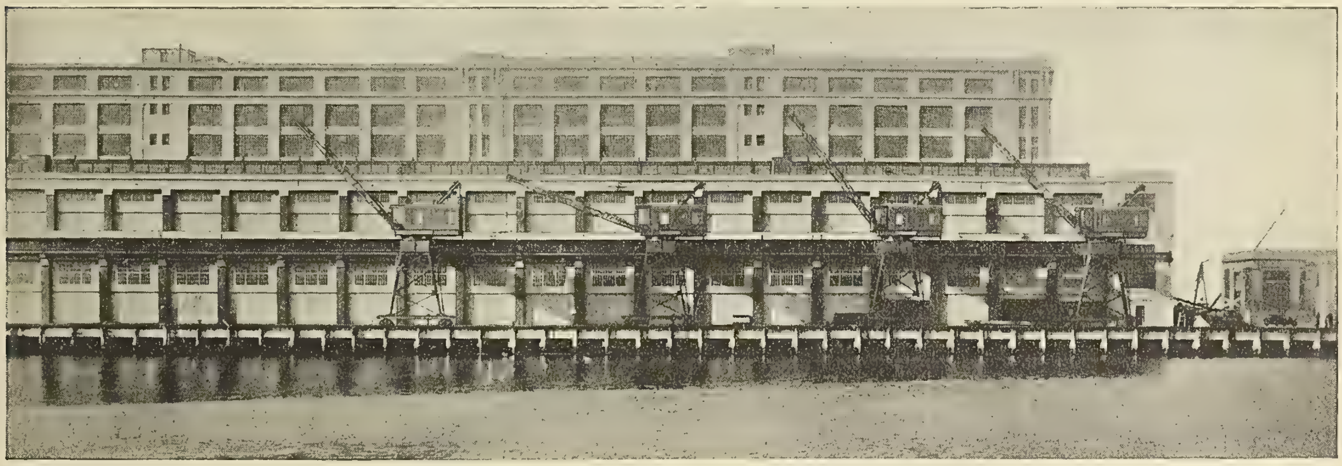


Fig. 3.—U. S. Army Supply Base, Boston, Showing Four Wellman-Seaver-Morgan Semi-Portal Bridge Type Dock Cranes Equipped With Motors and Magnetic Control Equipment

the buildings, electric cranes and winches for loading, storage battery tractors and various piling machines for disposing the packages in the sheds.

The elevator equipment consists of four elevators per section, or twenty-four for the whole storehouse, five in the wharf and sixteen in the pier sheds. The whole operation of these elevators—opening the door, starting, stopping, etc.—is entirely automatic and is controlled from the dispatcher's desk, thus removing the necessity for operators and simplifying the system of operation.

The loading and unloading from the ships is done by four semi-portal bridge cranes, which span the landing platform in front of the wharf shed. They are driven by 230-volt, direct current General Electric motors controlled by magnetic panels and have a 5,000-pound capacity at 250 feet per minute. In addition, there are sixteen electric winches with local and two with remote control. The control of a number of these winches is through magnetic panels with portable master controllers with flexible armored cable connection, which permit the operator to take a position where he can watch his load irrespective of the location of the winch.

The movement of packages about the buildings and between the wharf shed and the storage house is accomplished by means of storage battery tractors, pulling trains of from four to eight cars, while actual piling is done by mechanical piling devices, some electric and others not. The electric pilers are of the slat conveyor type with an average capacity of 40 tons per hour.

The installation of this modern electric type of apparatus, combined with the careful planning of the general layout of the buildings, wharves, railroads, etc., permits the loading and storing of two hundred carloads or 6,000 tons of freight per ten-hour day, and the loading of an 8,000-ton vessel in about two and one-half days. Although this condition is more or less ideal, it could be approached in most marine terminals, even those which have been in operation for some time.

The Merchant Marine Act a Reality at Last

BY WALDON FAWCETT

A solution, in so far as national legislation can provide it, for all the principal problems incident to the promotion and maintenance of the American merchant marine is sought in a comprehensive Merchant Marine Act, approved by Congress on June 5. Manifestly the new statute is the most ambitious attempt ever made in the United States to foster and encourage the development of the shipping and shipbuilding industries. Probably, moreover, it ranks as the most pretentious single legislative programme, whereby any government in the world has undertaken to cultivate and expand its water-borne commerce and all the transportation utilities dependent thereon. The main features of this new legislation are outlined in this article.

FEW of the most ardent advocates of legislation designed to create a permanent national policy with respect to the American merchant marine were sanguine that the desired enactments could be obtained during the second session of the Sixty-sixth Congress of the United States. Yet, if the responsibility be not met before the autumn of 1920, there was danger that the whole question might become a controversial issue in a national political campaign, with all the risks that partisan debate entails. Fortunately for the future of the merchant marine, rapid progress was made in the late spring in reconciling the differences of opinion between the Senate and the House of Representatives on merchant marine policies, and the two branches of the national legislature, seemingly so far apart in viewpoint in the beginning, arrived with unbelievable celerity at a basis of compromise.

Private Ownership the Underlying Principle

The Merchant Marine Act, which comprises thirty-nine sections, covering twenty-four printed pages, opens with the declaration that it is necessary for the national defense and for the proper growth of its foreign and domestic commerce that the United States shall have a merchant marine of the best equipped and most suitable types of vessels sufficient to carry the greater portion of its commerce and serve as a naval or military auxiliary in time of war or national emergency. Accordingly, it is declared to be the policy of the United States to do whatever may be necessary to develop and encourage the maintenance of such a merchant marine.

Set forth at the very outset as an underlying principle is the policy of private ownership and operation of merchant vessels, and this article of faith is prescribed for the guidance of the United States Shipping Board in the disposition of vessels and shipping property. To this same board is commended the government's desire to encourage in every possible way the upbuilding of the merchant marine as a consideration to be ever borne in mind in the making of rules and regulations and in the administration of the shipping laws. The new Merchant Marine Act repeals certain emergency legislation enacted during the war period, but the repeal is subject to the limitation that all contracts or agreements lawfully entered into before the passage of the new law are to be assumed and carried out by the Shipping Board. The Board is given full power and authority to complete or conclude any construction work undertaken in consequence of the war emergency, but it is directed that the Board shall as soon as practicable adjust, settle and liquidate all matters embraced in the war programme.

Shipping Board Becomes Permanent Institution

Under the Merchant Marine Act the United States Shipping Board becomes a permanent institution to be composed of seven commissioners (appointees of the President), who are required to devote their entire time to the duties of this office and who will receive, each, a salary of $12,000 per annum. In order to preserve a proper balance of representation for America's diverse shipping interests, it is stipulated that two of the commissioners shall be from the Pacific coast, two from the Atlantic seaboard, one from the shores of the Gulf of

Mexico, one from the states touching the Great Lakes, and one from the interior. It is further stipulated that not more than four of the commissioners shall be appointed from the same political party.

By the mandate all vessel property of the United States Government, other than vessels in military and naval service, is transferred to the Shipping Board, and then follows a specific instruction that goes to the heart of the immediate policy of the American merchant marine. In so many words the Shipping Board is directed to sell as soon as practicable, consistent with good business methods and the objects and purposes of the new legislation, all the vessels within its jurisdiction. After due appraisement the disposal of vessel property may be at public or private competitive sale and on such terms and conditions as the Board may prescribe, save that completion of the payment of purchase price and interest shall not be deferred for more than fifteen years after the making of the contract of sale. In fixing or accepting a sale price on the vessels, the Board is instructed to take due account of the prevailing domestic and foreign market prices, the available supply of vessel property, the demand for vessels, existing freight rates and prospects of their maintenance, the cost of constructing vessels of similar types under prevailing conditions, and other factors—in short, all the facts and conditions that would influence a prudent, solvent business man in the sale of similar vessels or property which he is not forced to sell.

Transfer of Government Owned Vessels

Under the authorization above reviewed the Shipping Board has authority to transfer its vessel property only to persons "who are citizens of the United States," but this is followed by a paragraph which notes exceptions in favor of aliens. The Board is empowered to sell to aliens such vessels as it shall after careful investigation deem unnecessary to the promotion and maintenance of an efficient American merchant marine, but it is stipulated that no such sale shall be made unless "diligent effort" has been made to find buyers among the citizens of the United States. An extra exaction in the case of alien purchasers of vessel property is that deferred payments of purchase price shall bear interest at a rate of not less than 5½ percent per annum, payable semi-annually, and that completion of payments shall not be deferred more than ten years.

Practical shipping men and shipbuilders are likely to find of especial interest Section 7 of the new act, which directs the Shipping Board to investigate from time to time and determine what steamship lines should be established from the United States or its possessions to the world and domestic markets where the development, expansion and maintenance of American commerce may be desirable. The needs of an adequate postal service, as well as the promotion of foreign and coastwise trade, are to weigh with the Board in such investigations, and the conclusions to be reached by the official body are to cover the type, size and speed of vessels, as well as the frequency of sailings.

Development of New Steamship Lines

In encouragement of the establishment of regular and permanent service on the routes where there is need, the Shipping Board may charter vessels to responsible citizens of the United States if it is unsuccessful in persuading any ship operator to undertake the responsibility on the basis of outright purchase of the requisite tonnage. Or if no citizen can be induced to supply the needed service, the Board is advised to operate vessels on lines where there is need until the business is developed so that the vessels involved may be sold on satisfactory terms and the service maintained, or until it has been determined that such a line cannot be made self-sustaining.

Preference in the sale or assignment of vessels for operation on the new or needed steamship lines must be given, under this law, to those citizens of the United States who have the support, financial and otherwise, of the domestic communities primarily interested in the lines. Similar preference is bespoken for United States citizens who are already maintaining a service from the port of the United States to or in the general direction of the world market port to which the Board has determined that such service should be established. Incorporated in this section of the law is a reservation to the effect that where steamship lines and regular service have already been established by ships of the Board, such lines and service shall be continued until in the opinion of this Federal board of directors the maintenance is unbusinesslike or against public interest. Tacked to this same declaration of policy is another proviso to the effect that where government service parallels a shipping service already given by private citizens of the United States, the rates and charges of the Government service must not be less than the actual cost thereof, including a proper interest and depreciation charge on the value of the government vessels and equipment employed.

Port Facilities to Be Improved

In Section 8 of the new law is the embodiment of the sentiment that it is the province of the Government to "go behind" the physical status of American shipping and seek the betterment of port facilities and transportation arrangements in the territory tributary to the respective ports of the Republic. The Shipping Board is delegated to co-operate with the Secretary of War in the promotion, encouragement and development of ports and transportation facilities. As part and parcel of this obligation, there is enumerated the investigation of the causes of congestion of commerce at ports and the remedies to be invoked; the suggestion of better equipment for handling freight; recommendations for port improvements, etc.

Construction Loan Fund Created

Progressive and constructive in purpose is that section of the new law which provides for the creation by the Shipping Board of what is to be known as a "construction loan fund," to be formed by the setting aside annually for a period of five years of sums not to exceed $25,000,000. The purpose of this fund is to provide aid for the construction of vessels of the best and most efficient type for the establishment and maintenance of steamship service on needed lines. The reserve fund thus created is to be allotted to citizens of the United States to aid them in the construction of ships in the private shipyards of the country. No aid is, however, to be for a greater sum than two-thirds of the cost of the vessel or vessels to be constructed, and the Board is instructed to require such security, including a first lien upon the entire vessel property, as may be deemed necessary to insure repayment.

Shipping Board to Become Supreme Court of Shipping

Seemingly it was the intent of Congress in its latest legislation to give to the Shipping Board the status of a "supreme court of shipping" with powers paralleling those which recent legislation for the regulation of the railroads conferred on the Interstate Commerce Commission and which have caused the latter to be nicknamed "the

supreme court of the railroads." Thus we behold the grant of authority to the Shipping Board, as newly credentialed, to make rules and regulations affecting shipping in the foreign trade when necessary to adjust or meet special conditions unfavorable to shipping in that trade, whether in any particular trade or upon any particular route, or in commerce generally. Such conditions may result from foreign laws and regulations or may arise out of competitive methods or practices resorted to by foreign owners and operators of vessels. In order to make the Shipping Board an authoritative clearing house for all governmental regulations affecting shipping and waterborne commerce, it is set down in the new law that hereafter no rules or regulations affecting shipping in the foreign trade shall be promulgated by any governmental agency (other than the Public Health Service, Steamboat Inspection Service, etc.) unless approved by the Shipping Board.

On and after February 1, 1922, the coastwise laws of the United States are, by this new enactment, extended to the island territories and possessions of the United States not now covered thereby and the Shipping Board is directed to establish, before the expiration of 1922 adequate steamship service at reasonable rates to accommodate the commerce and passenger travel of these islands and to maintain and operate that service until it can be taken over by private capital. Special provisions, in connection with the main authorization, take care of the situation in the Philippines. The new law puts an end to the suspension of the prohibition laid against foreign-built vessels and vessels of foreign registry in the coastwise trade of the United States, but an exception is made in favor of foreign built vessels that came in under the war-time immunity, so long as they continue in the possession of the United States citizens who took them over under the concession made in the year 1917.

Deduction of War and Excess Profits Taxes

Vital to the economic side of the uplift of the American merchant marine is Section 23 of the new law, which permits the owner of an American vessel engaged in the foreign trade to deduct, each year during the next decade, the net earnings of his vessel when computing so-called war profits and excess profits taxes. This exemption from special taxation is, however, contingent upon the setting aside by the vessel owner of a sum equivalent to his remitted taxes to be devoted to the building in the shipyards of the United States of new vessels of a type and kind to be approved by the Shipping Board. There is a further requirement that when vessels are thus constructed in compliance with this relief from the burdens of special taxation at least two-thirds of the cost of any vessel shall be paid for out of the ordinary funds or capital of the person who has the vessel constructed. In like manner any citizen of the United States who may during the next ten years sell a vessel built prior to January 1, 1914, will be exempt from all income taxes upon the proceeds, if he will invest the entire proceeds in new ships to be built in American shipyards.

With the manifest purpose of encouraging by every possible means the upbuilding of the American merchant marine, we find in the new statute provisions that all mails of the United States shall, if practicable, be carried on American built vessels and that cargo vessels documented under the laws of the United States may carry not to exceed sixteen persons in addition to the crew. All boards, bureaus and departments of the government are directed to recognize the American Bureau of Shipping as their agency for the classification of vessels. In Section 27 of the lately approved statute we find a determined effort to restrict to vessels of American construction and registry the transportation of merchandise between ports in the United States and its territories and possessions no matter whether the transit be direct or via a foreign port. Special provision is made, however, for commerce that is in part over Canadian rail lines and their connecting water facilities, and this section of the law will not become effective upon the Yukon River until the Alaska Railroad shall be completed.

Vessel Sales, Conveyances and Mortgages

The entire latter part of the new Merchant Marine Act is devoted primarily to the subject of "sales, conveyances and mortgages" of vessels of the United States, and space does not permit an analysis in detail at this time of the provisions of this part of the statute, important as they are. Readers of Marine Engineering will recall that the original contemplation in Congress was for the passage of a "ship mortgage bill" as a separate act, but it was decided upon reflection that the subject bore such intimate relationship to the larger aspects of the future merchant marine that it would be preferable to incorporate in the main measure the provisions that first appeared as a separate bill. The various lengthy subsections devoted to this subject cover the recording of sales and mortgages, the foreclosure of preferred mortgages, transfers of mortgaged vessels and assignment of vessel mortgages, maritime liens for necessaries, and other vital phases of the subject. By and large, the effect of this establishment of conservative, consistent public policy with respect to vessel ownership and control is expected to be the attraction to vessel property of a vast aggregate of investment funds which have heretofore sought other channels.

Marine Insurance

Incorporated in the Merchant Marine Act are several sections that prescribe with definition the policy to be followed by the Shipping Board with respect to marine insurance, although Congress has not gone as far as some enthusiasts would have had it go in encouragement of all-American insurance facilities for private shipping. It is stipulated, for one thing, that the Shipping Board shall require that every purchaser of one of its vessels under the deferred payment plan shall keep the vessel insured in such amount as the Board may prescribe or approve. Authority is also given the Shipping Board to create out of the net revenue from operations and sales a separate fund which it may use to insure in whole or in part any interest of the United States in any vessel built or building, or in any plant or materials.

European Motorship Building

(*Concluded from page 587.*)

direct from these pumps to the individual valves arranged in the cylinder cover in the ordinary way and operated by valve levers from the camshaft. The fuel consumption of the engine works out at 0.42 pound per brake horsepower hour, which is only slightly higher than that of the Burmeister and Wain type motor. The total consumption for the 10,000-ton tanker on her official trials at 11 knots was 13 tons per day, including all the steam driven auxiliaries. This vessel has been built for the Anglo American Oil Company, for whom a second similar ship is now under construction and will be put into commission late in the summer.

Testing the Hull Structure of Ships—II

Watertight Bulkheads—Rules and Methods for Testing Tanks Used for Carrying Fuel Oil—Fuel Oil Bunkers and Settling Tanks

BY F. K. RUPRECHT

TEST NO. 6.—AFTER COLLISION BULKHEAD

(*a*) *Object*

To test strength and tightness of the bulkhead and tightness of all connections thereto. While the shell must of course be tight, the test is primarily to test the bulkhead.

(*b*) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

While there is no definite rule to cover this particular case, it appears that a hose test is all that would be required, the pressure in the nozzle to be at least 30 pounds per square inch.

2. British Lloyd's Register.

To be tested by filling the peaks with water to the height of the load waterline.

3. Bureau Veritas.

To be tested by filling the fore peak with water. (Note.—No head is given, but it is assumed that it shall be to the freeboard deck or at least to the load waterline.)

(*c*) *Procedure of Testing*

Test before cementing, cement washing or painting with bitumastic and before launching, if possible, although the latter is not a requirement, and after all work within and adjacent to the bulkhead has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to launching date or other contingencies, the final approval of test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a re-test obligatory.

Fill the after peak compartment, i. e., that space between the stern and the collision bulkhead, with water to a height equal to *at least* the load waterline. If there is a calked watertight deck above this level, it is well to fill to this level, since this would be more nearly the head the bulkhead must withstand in case of a damaging collision. No leaks should develop at this head and the deflection of the bulkhead should be reasonably small. Any leaks which are found should be made good by legitimate means and any excess deflection should be corrected by additional stiffening, all to the satisfaction of the surveyor.

TEST NO. 7.—WATERTIGHT BULKHEADS OTHER THAN COLLISION OR TANK BULKHEADS

(*a*) *Object*

To test the tightness of the bulkheads and all fittings and connections thereto.

(*b*) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

To be tested with a hose, the pressure of water being not less than 30 pounds per square inch, under simultaneous inspection on both sides of the plating.

2. British Lloyd's Register.

To be tested with a hose, the pressure of water in the hose being not less than 30 pounds per square inch, under simultaneous inspection on both sides of the plating.

3. Bureau Veritas.

To be tested with a hose. (Note.—No requirement as to pressure is given.)

(*c*) *Procedure of Testing*

Test before cementing, cement washing or painting with bitumastic, but at any convenient time and after all work within and adjacent to bulkhead has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, the final approval of test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a re-test obligatory.

Direct a stream of water from a hose at the required pressure against the bulkhead in a systematic manner so as to test the tightness of all boundary angles, seams and butts, and all rivets, watertight doors and pipe connections, starting at the bottom and working up from side to side as directed by the surveyor and at a speed which will permit careful inspection by a surveyor on the opposite side. Any leaks detected are to be made good by legitimate means and to the satisfaction of the surveyor.

TEST NO. 8.—FORE PEAK TANK, IF USED FOR FUEL OIL

(*a*) *Object*

To test oiltightness and strength of peak bulkhead, shell in way of tank, deck forming crown of tank, manholes, hatches and pipe connections to bulkhead, tank top or shell.

(*b*) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

To be tested with a head of water at least one foot above the highest point to which oil has access in pipes (vent, overflow of filling lines), hatchways or elsewhere; or to a head of not less than eight feet above the highest point of the compartment, whichever is highest.

2. British Lloyd's Register.

To be tested with a head of water extending to the highest point of the filling pipes or twelve feet above the load waterline or twelve feet above the highest point of the compartment, whichever of these is the greater. In the 1920 edition of Lloyd's Rules the requirement of twelve feet above the load waterline has been modified to read to load waterline. The alternative requirements, however, are unchanged.

3. Bureau Veritas.

To be tested with a head of water extending to the upper deck, and at least thirteen feet above the crown of the tank.

(*c*) *Procedure of Testing*

Test before launching and before painting or coating with bitumastic and after all work within the tank and adjacent to the tank has been completed and the work-

manship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to some contingency, the final approval of test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a re-test obligatory.

Fit a standpipe onto tank top (vent or filling connection may be used) and carry the pipe to the prescribed height fitting a large funnel or other container at the top, the height of which is to be such as to show the level of the water when at the testing head. No leaks or defects should develop at this pressure, and any found should of course be made good by legitimate means to the satisfaction of the surveyor. Often it is not possible to test completely before launching, and in this contingency it is necessary to have a preliminary test to insure the tightness of the shell in way of tank. In this case the tank is filled with water to the level of the crown of the tank and the shell is made tight to the satisfaction of the surveyor.

Since the tank is to carry oil, and in view of the fact that oil is more searching than water, the surveyor's inspection and test will usually be more rigid and a superior job will be insisted upon throughout.

Test No. 9.—After Peak Tank, If Used for Fuel Oil

(*a*) *Object*

To test oiltightness and strength of peak bulkhead, shell in way of tank, deck forming crown of tank, manholes, hatches and pipe connections to bulkhead, tank top or shell.

(*b*) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

To be tested with a head of water at least one foot above the highest point to which oil has access in pipes (vent, overflow of filling lines) hatchways or elsewhere; or to a head of not less than eight feet above the highest point of the compartment, whichever is highest.

2. British Lloyd's Register.

To be tested with a head of water extending to the highest point of the filling pipes or twelve feet above the load waterline or twelve feet above the highest point of the compartment, whichever of these is the greater. In the 1920 edition of Lloyd's Rules the requirements of 12 feet above the load waterline has been modified to read to load waterline. The alternative requirements, however, are unchanged.

3. Bureau Veritas.

To be tested with a head of water extending to the upper deck, and at least thirteen feet above the crown of the tank.

(*c*) *Procedure of Testing*

Test before launching and before painting or coating with bitumastic and after all work within and adjacent to the tank has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to some contingency, the final approval of test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a re-test obligatory.

Fit a standpipe onto the tank top (vent or filling connections may be used) and carry the pipe to the prescribed height, fitting a large funnel or other container at the top, the height of which is to be such as to show the level of the water when at the testing head. No leaks or defects should develop at this pressure, and any found should of course be made good by legitimate means to the satisfaction of the surveyor. Often it is not possible to test completely before launching, and in this contingency it is necessary to have a preliminary test to insure the tightness of the shell in way of tank. In this case the tank is filled with water to the level of crown of the tank and the shell made tight to the satisfaction of the surveyor.

Since the tank is to carry oil, and in view of the fact that oil is more searching than water, the surveyor's inspection and test will usually be more rigid and a superior job will be insisted upon throughout.

Test No. 10.—Double Bottom Tanks, If Used for Fuel Oil

(*a*) *Object*

To test oiltightness of shell plating in way of double bottom tank top plating, and margin plate strength and tightness of watertight floors and centerline division plating (centerline girder), manholes and pipe connections to tank top, watertight floors, centerline girder or to shell.

(*b*) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

To be tested before launching with a head of water at least one foot above the highest point to which oil has access to pipes, i. e., (filling vent or overflow pipes).

2. British Lloyd's Register.

To be tested with a head of water extending to the highest point of the filling pipes or twelve feet above the load waterline.

3. Bureau Veritas.

To be tested before launching with a head of water extending to the upper deck.

(*c*) *Procedure of Testing*

Test before launching and before painting with bitumastic or cementing or cement washing, and after all work within and adjacent to the tank has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to launching date or other contingencies, the final approval of the test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a re-test obligatory. Each tank is to be tested separately so all sides of divisional floors or girders such as watertight centerline girder may be observed.

Fit a standpipe to the tank top (vent or filling line may be used) with a large funnel or other container at the top and at such a height that the level of the water at the required head will show in the container. No leaks or defects should develop at this head, and any found should be made good by legitimate means to the satisfaction of the surveyor.

Since these tanks are to carry oil, and in view of the fact that oil is more searching than water, the surveyor's inspection and test will usually be more rigid and a superior job will be insisted upon throughout.

Test No. 11.—Deep Ballast Tanks, If Used for Fuel Oil

(*a*) *Object*

To test the oiltightness and strength of the boundary

bulkheads, deck forming the crown of the tank, longitudinal divisional bulkheads (one at least on centerline is usually required), shell in way of tank, inner bottom in way of tank in double bottom vessels, all manholes, hatches, hatch covers and pipe connections to tank top, inner bottom, bulkheads or shell.

(*b*) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

To be tested with a head of water at least one foot above the highest point to which oil has access in the pipes (i. e., vent, overflow or filling lines), hatchways or elsewhere; or to a head of not less than eight feet above the highest point of the compartment, whichever is highest.

2. British Lloyd's Register.

To be tested with a head of water extending to the highest point of the filling pipes or twelve feet above the load waterline or twelve feet above the highest point of the compartment, whichever of these is the greater.

3. Bureau Veritas.

To be tested with a head of water extending to the upper deck, and at least thirteen feet above the crown of the tank.

(*c*) *Procedure of Testing*

Test before launching and before painting with bitumastic or cementing or cement washing and after all work within and adjacent to tank has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to launching date or other contingencies, the final approval of the test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a re-test obligatory.

Fit a standpipe to the tank top (vent or filling line may be used) with a large funnel or other container at the top and at such a height that the level of the water at the required head will show in the container. No leaks or defects should develop at this head, and any found should be made good by legitimate means to the satisfaction of the surveyor. Often it is not possible to test completely before launching, and in this contingency it is necessary to have a preliminary test to insure the tightness of the shell in way of the tank. In this case the tank is filled with water to the level of the crown of the tank and the shell made tight to the satisfaction of the surveyor.

Since the tank is to carry oil, and in view of the fact that oil is more searching than water, the surveyor's inspection and test will usually be more rigid and a superior job insisted upon throughout.

TEST NO. 12.—FUEL OIL BUNKERS

(*a*) *Object*

To test the oiltightness and strength of the transverse and longitudinal boundary bulkheads, the deck forming the crown of the tank, the shell in way of the tank, the inner bottom in way of the tank in double bottom vessels, all manholes and hatches and pipe connections to the top, sides or bottom of the tank.

(*b*) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

To be tested with a head of water at least one foot above the highest point to which oil has access in pipes (i. e., vent, overflow or filling lines), hatchways or elsewhere; or to a head of not less than eight feet above the highest point of the compartment, whichever is highest.

2. British Lloyd's Register.

To be tested with a head of water extending to the highest point of the filling pipes or twelve feet above the load waterline or twelve feet above the highest point of the compartment, whichever of these is the greater.

3. Bureau Veritas.

To be tested with a head of water extending to the upper deck, and at least thirteen feet above the crown of the tank.

(*c*) *Procedure of Testing*

Test before launching and before painting with bitumastic or cementing or cement washing on outside, because, of course, no paint or coating of any kind will be used inside of tanks, and after all work within and adjacent to the tank has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to launching date or other contingencies, the final approval of the test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a re-test obligatory.

Fit a standpipe to the tank top (vent or filling line may be used) with a large funnel or other container at the top and at such a height that the level of the water at the required head will show in the container. No leaks or defects should develop at this head, and any found should be made good by legitimate means to the satisfaction of the surveyor. Since the tank is to carry oil, and in view of the fact that oil is more searching than water, the suveyor's inspection and test will usually be more rigid and a superior job insisted upon throughout.

TEST NO. 13.—FUEL OIL SETTLING TANKS

Note.—This test only applies where the settling tanks form an integral part of the ship's structure and *not when the tanks are independent of the hull.*

(*a*) *Object*

To test the oiltightness and strength of the transverse and longitudinal boundary bulkheads, the deck forming the crown of the tank, the shell in way of the tank, the inner bottom in way of the tank in double bottom vessels, all manholes and hatches and pipe connections to the top, sides or bottom of the tank.

(*b*) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

To be tested with a head of water at least one foot above the highest point to which oil has access in pipes (i. e., vent, overflow or filling lines), hatchways or elsewhere; or to a head of not less than eight feet above the highest point of the compartment, whichever is highest.

2. British Lloyd's Register.

To be tested with a head of water extending to the highest point of the filling pipes or twelve feet above the load waterline or twelve feet above the highest point of the compartment, whichever of these is the greater.

3. Bureau Veritas.

To be tested with a head of water extending to the upper deck and at least thirteen feet above the crown of the tank.

(*c*) *Procedure of Testing*

Test before launching and before painting with bitu-

mastic or cementing or cement washing on outside of tank, because, of course, no paint or coating of any kind will be applied inside of the tank, and after all work within and adjacent to the tank has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to launching date or other contingencies, the final approval of the test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a re-test obligatory.

Fit a standpipe to the tank top (vent or filling line may be used) with a large funnel or other container at the top and at such a height that the level of the water at the required head will show in the container. No leaks or defects should develop at this head, and any found should be made good by legitimate means to the satisfaction of the surveyor. Since the tank is to carry oil, and in view of the fact that oil is more searching than water, the surveyor's inspection and test will usually be more rigid and a superior job insisted upon throughout.

(*To be concluded.*)

Graphic Illustration of Extensive Use of Oxy-Acetylene in Shipyards

The arrangement of the Toledo Shipbuilding Company's yards at Toledo, Ohio, shown in Fig. 1, is interesting not only on account of the unique arrangement of the launching ways alongside the company's dry docks into which the vessels are launched sideways, but also because it affords a graphic illustration of the extent to which the use of oxy-acetylene enters into present-day shipbuilding. This yard is one of the most extensive users of oxy-acetylene in the Great Lakes district and is a model in equipment.

The Toledo yard makes its own acetylene, operating a 500-pound duplex generator which supplies its distributing system, but it is none the less a fair illustration of the general use of oxy-acetylene in yards that purchase dissolved acetylene gas in cylinders. In fact, acetylene gas is supplied in cylinders at this yard wherever there is need for acetylene at any distance from the stations. Liquid air oxygen is used exclusively.

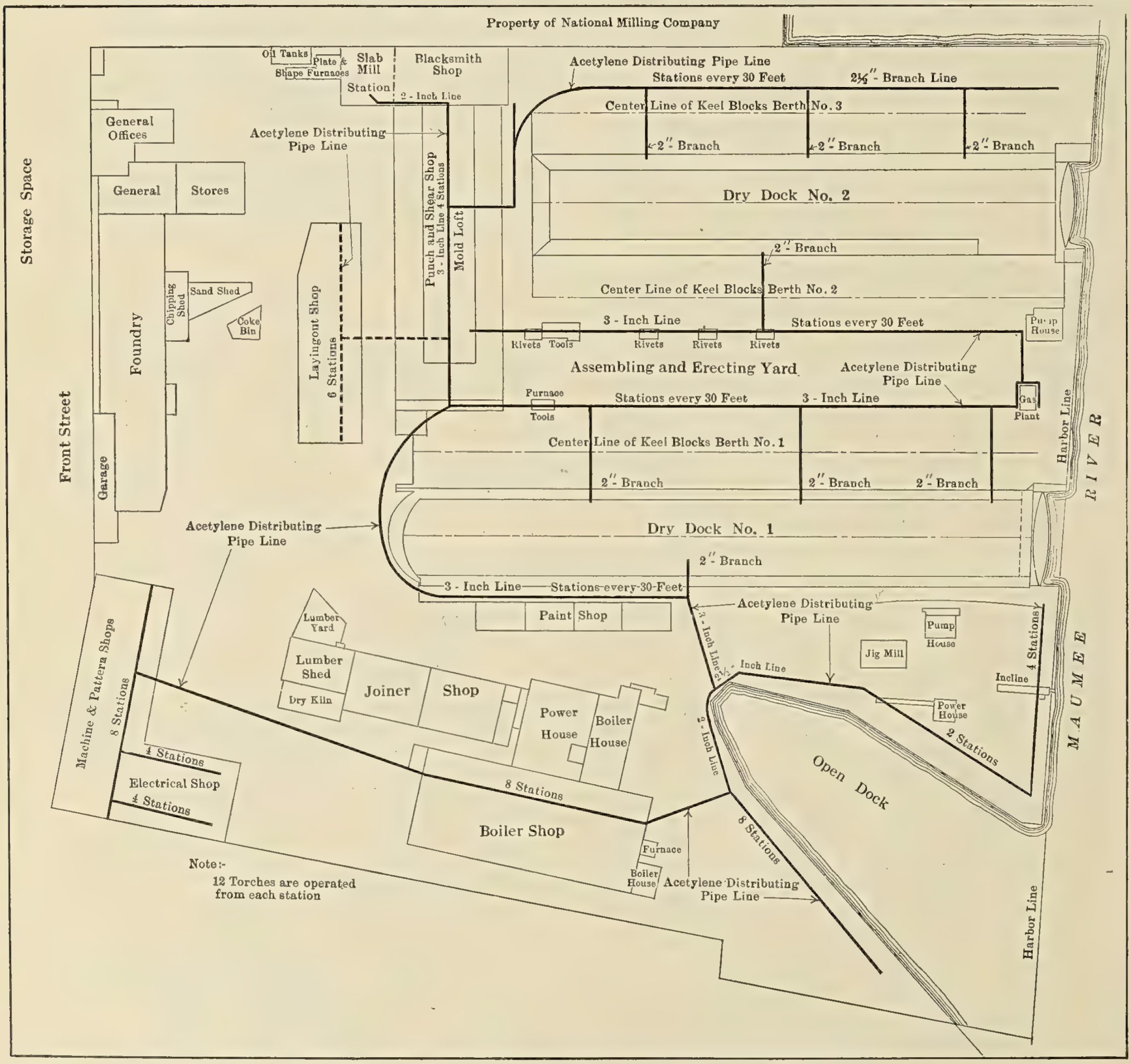


Fig. 1.—Plan of Toledo Shipyard, Showing Location of Acetylene Distributing Lines

The following table gives the number and location of welding and cutting stations shown in the drawing:

Location and Number of Welding and Cutting Stations

Building Berth No. 1	22
Building Berth No. 2	18
Building Berth No. 3	18
Dry Dock No. 1	4
Dry Dock No. 2	4
Around Open Dock	22
Boiler Shop	8
Slab Mill	1
Punch and Shear Shop	4
Laying Out Shop	6
Pipe Line Shop	4
Sheet Metal Shop	4
Machine Shop	8
Total Number of Stations	115*

The use of oxy-acetylene in the Toledo Shipbuilding Company's yard has been an interesting development, growing steadily with the expansion of the range of applications authorized by the American Bureau of Shipping as rapidly as they were found suited to the work done in this plant. Today these applications constitute an imposing list, including the following items:

Welding.—Deck rail stanchions to plating; clips for detachable rail stanchions; skylights over galley; engine room stairs and gratings; boiler room stairs and gratings; all stairs and ladders, including all rail attachments; door frames to casing, hinges, catch hold coach hooks, etc.; coal chutes; engine room skylights; corners on water tanks; heads in water and filter tanks; framing and supports for engine and boiler room flooring or grating; cargo batten cleats; tanks that are not structural parts; shaft alley escapes; wash plates.

Cutting.—Cutting off all frames; cutting of all angles used on boat; cutting headlights and manholes; cutting inside circle on all plates or all irregular shapes that can be sheared; cutting all scrap.

Repairs.—Heating and straightening braces and machine repair.

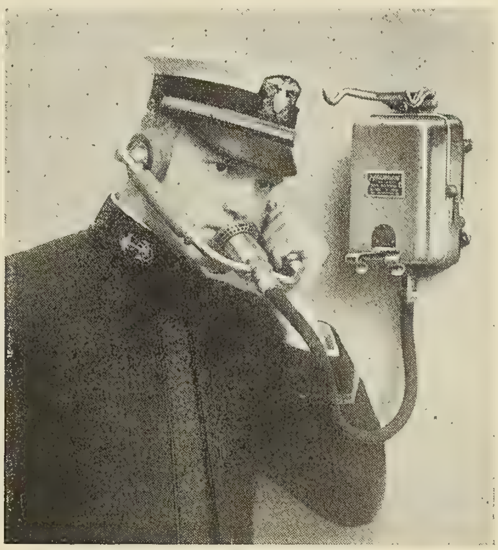
Anti-Noise Marine Telephone Inter-Communication Systems

It is essential in the operation of a vessel that the source of communication between the bridge, main engine room and steering engine room be absolutely reliable. Two means of communication are possible, the engine telegraph, by which the engine signals are transmitted from the bridge to the engineer, or some method of voice transmission. In an emergency, this latter is very essential, for a word or two from the captain to the engineer might prevent serious damage to the vessel.

With the slow-moving reciprocating engine and hand-fired boilers the noise in the fireroom and engine room is not of such volume as to interfere to any extent with the voice tube method of communication, but in the great majority of ships, with the noise of the reduction gears of high-speed turbines and the roar of oil burners, this method is practically useless.

In studying the requirements of inter-communication systems, it was first thought that a very loud-speaking telephone would solve the difficulty, so a system of this type was developed and installed in many ships. It did not, however, overcome the noise conditions, for the roar in the engine room made it almost impossible to understand orders from the bridge. On the bridge itself, the noise is nearly as great as in the engine room, caused by the whistling of the wind through the rigging, seas breaking over the bow, the running of deck winches and the thousand and one other noises accompanying the operation of a ship. After exhaustive trials, it was decided that although the loud-speaking instrument was satisfactory in quiet surroundings it did not fill the requirements for intercommunication aboard ship.

A final solution of the problem came in the development of intercommunication telephones for use on the seaplanes of the United States Navy by the Magnavox Company, Oakland, Cal. The problem here was really worse than on board ship, for it would be difficult to imagine a noisier place than the cockpit of a flying boat, with the rush of the wind between the planes and the roar of unmuffled, high-powered motors. As soon as war restrictions were removed the device was adapted to marine



Anti-Noise Marine Telephone in Use

service, being installed on merchant vessels, passenger liners, oil tankers and also on the latest type destroyers.

The apparatus has been given the name Magnavox anti-noise telephone for the reason that a simple, balanced diaphragm transmitter eliminates noises from outside sources. The diaphragm is exposed both back and front, so that all noises strike the diaphragm with equal force on both sides. Under this condition, it is claimed, there is no vibration of the diaphragm, the electrical circuit remains undisturbed, and nothing is transmitted over the wire. When speaking directly into the instrument, however, vibrations on one side of the diaphragm are intensified and the electrical impulses set up by the vibrations are reproduced at the other end of the line. At this point the receiver is of the electro-dynamic type, which reproduces the voice clearly and slightly amplified.

The apparatus is arranged in various systems so that it is possible to call any part of the ship from the master station, or to call the master station from the sub-station. With slight alterations the sub-stations may call each other through connections made by means of selective control switches.

Shipbuilding Returns

The Bureau of Navigation, Department of Commerce, reports 164 sailing, steam, gas and unrigged vessels of 251,442 gross tons built in the United States and officially numbered during the month of April, 1920. About three-quarters of this tonnage consists of vessels owned by the United States Shipping Board. From other sources than construction ten vessels of 34,633 gross tons were admitted to American registry.

* Twelve torches may be used at each station.

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WE GUARANTEE that of this issue 9,350 copies were printed; that of these 9,350 copies 7,835 were mailed to regular paid subscribers, 500 were provided for counter and news company sales, 308 were mailed to advertisers, 57 were mailed to employes and correspondents, and 650 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 71,350—an average of 10,193 copies a month.

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The American Bureau of Shipping

IT was to be expected that the action of the Shipping Board, in ordering its managers and operators to have all vessels owned by the Board classed by the American Bureau of Shipping, would receive more or less adverse criticism in Great Britain. Now that the new Merchant Marine Act has gone still further in directing that all departments, boards, bureaus and commissions of the government are to recognize the American Bureau of Shipping as their agency, there will probably be many predictions of disaster to our shipping industry from English sources.

If the statement made by one British paper "that American vessels, when they carry the prestige of Lloyd's Registry, are often insured on practically the same terms as British-built vessels, although the risks can not be considered equal in quality" is true, then we are certainly under deep obligations to that institution. It is a fact, however, that a large number of vessels have been designed, built and classified to the rules of the American Bureau and that these vessels have proved themselves to be seaworthy in every respect. Going still further, the Navy Department has succeeded in designing and building its war vessels without the aid of any classification society and no one will venture to say that these vessels have not given a good account of themselves.

If we are able to build good vessels, it ought to be apparent that we should be able to survey them. A statement that "the ability of the Bureau's surveyors is an unknown quality" is an injustice because they are known to be men of long experience in shipbuilding and are recruited from the shipyards. As the position of surveyor is a desirable berth the Bureau has been able to secure men of more than average ability for this work.

One of our English contemporaries apparently believes that all vessels, whether private or government-owned, must be classified by the Bureau and that this work will be done free of charge. It says, "the fact that they are offering a certificate of classification by the Bureau free of cost, will probably result in the compliance of the American owners with the arbitrary order which has just been issued." The Government has no intention of compelling any owner to classify his vessel with the Bureau, it is simply setting the good example of patronizing an efficient American institution for this work and at the same time securing uniformity of classification for its vessels.

Passing to the question of construction rather than chartering or insurance, it is the belief of many that Lloyd's rules require heavier scantlings than are necessary for safety. The fact that Lloyd's classify longitudinally framed vessels of lighter weight than similar vessels having transverse frames, although the frames of the former type are cut and bracketed at the bulkheads, would indicate that the rules of the American Bureau, which lie between the types mentioned above, are more rational and economical as regards the weight of steel.

The Most Efficient Type of Vessel

ONE of the sections of our new Merchant Marine Act provides that "the Shipping Board may annually set aside for a period of five years, out of the revenue from sales and operations, a sum not exceeding $25,000,000, to be known as its constructive loan fund, to be used in the construction, or in aid of the construction, of vessels of the best and most efficient type and that such vessels shall be equipped with the most *modern*, the most *efficient* and the most *economical* machinery and commercial appliances."

The most efficient type of vessel will depend upon the requirements of the service for which it is designed. It is apparent that dimensions, characteristics and arrangement of holds and quarters, that are suitable for a proposed vessel, will depend on whether it is a freighter, tanker, passenger, combination or other type of vessel; whether it is a slow, medium or high speed vessel; what the character of the cargo or the number of passengers that it is designed to carry is, as well as on the depth of harbors and many other things.

Passing over the question of the best shape and structure for the hull, do the phrases "the most *modern*, the most *efficient* and the most *economical* machinery" mean that the framers of this section of the shipping bill had in mind a particular type of machinery to the exclusion of all others? While it would be difficult to get a representative committee of naval architects to agree on the best design for a particular class of vessel, what shall be said of the possibility of securing a decision from a committee of representative engineers as to whether the reciprocating engine, the turbine, the electric drive, the Diesel or hot bulb engine is at the same time "the most modern, the most efficient, and the most economical type of machinery?" A partial list of the items upon which

such a decision would have to be based is as follows, viz.: the fuel consumption for installations of similar power including the *auxiliaries;* the comparative weights and the first cost; the volume, floor space and center of gravity of the installation; the vibration due to the inertia of reciprocating parts, liability of breaking down or stopping, ability to operate over a large power range without serious loss in economy; adaptability to low, medium and high speeds; the available supply of skilled men competent to handle the type of machinery selected, etc.

The Shipping Board should be in a position to gather some very valuable data on the relative economy of turbines and reciprocating engines. If this data can be supplemented by some information on similar vessels running under similar conditions powered with the Diesel engine direct connected, the Diesel engine with electric drive and the turbine with electric drive, a practical answer as to the best machinery for a given type of vessel may be obtained.

The Screw Propeller

WHEN the screw propeller was first used to drive ships, the engines were slow and the ships were slow, and conditions led to the use of a large propeller with a large pitch ratio such as one and a half. This was fortunate, as it aided in the introduction of the device. Seamen and all others connected with navigation are naturally conservative and, having a good thing, are likely to stick to it. In early days there was a tendency for the screw to get ahead of the engine, and geared engines were used in some cases—for example, on the *Wampanoag* built shortly after the Civil War. In that case the screw ran faster than the engine. To reduce shock and lessen noise, the gear wheel had wooden teeth, while the pinions were of cast iron, chipped and filed. This ship made an unusual speed of sixteen knots by the log and burned forty tons of coal a day.

When high speed was desired, especially for relatively small ships, the engines were speeded up and the screws had a smaller diameter and a smaller pitch ratio and ran with greater slip. The loss of economy was accepted as a penalty of high speed. The most notable development along the line occurred on torpedo boats and on destroyers.

But when steam turbines were applied to navigation, incompatible conditions gave trouble at once. The steam turbine is essentially a high speed machine and the screw propeller gives a good efficiency only when it has sufficient diameter and a large pitch ratio. Parsons, who first applied steam turbines on shipboard, went to the limit at both ends to join the turbine and propeller on the same shaft. He used turbines with many stages, and led the steam from turbine to turbine on two or three shafts. Other turbines are somewhat easier to adapt to ship propulsion, but all suffer from the same difficulty. Only high speed ships, large or small, can use direct connected steam turbines advantageously.

Parsons was the first to find the remedy, namely, the introduction of gearing, which for cargo ships is compounded.

When Diesel engines had won their way on shipboard, it was evident that high rotative speed was desirable to reduce the weight and cost of the engine; in this case the poorer efficiency of smaller screws, with a smaller pitch ratio, is accepted the more easily as the fuel economy is good. The internal combustion engine is not well adapted to driving through gearing.

Emmet's electric drive, as applied to battleships and battle cruisers, among its many advantages can drive the screw at the speed best adapted for economy. These types of ships have high speed and give excellent results with electric propulsion. Ships that have relatively low speed can be driven by this method, but the motors could be smaller and more efficient, if the speed of the screw could be increased.

The information for a discussion of the effect in practice of using higher speed screws with smaller pitch ratios is not in form for presentation at this time, if, indeed, it is in existence. Fortunately, we have in the diagram presented by Admiral Taylor means of looking into this question. There may be some uncertainty when model experiments are applied to full-sized propellers, but we may be sure that experiments give correct *relative* information; those conditions which give good results for models will give good results for ships. Across each diagram of properties of propellers Admiral Taylor draws an optimum line, which allows the designer to select those proportions that will give the best efficiency for his conditions. In a particular case this line shows the best economy at a pitch ratio of 1.6 and a real slip, allowing for wake of 14 percent. If the pitch ratio be reduced to unity, the slip increases to 26 percent and the efficiency falls from 74 percent to 65 percent. For once the conservatism of the seaman seems to be well founded.

Shipbuilding

IN view of the fact that the Shipping Board has requested the Interstate Commerce Commission to suspend the operation of the preferential export rates for American vessels for ninety days on the grounds that there would probably not be enough ships to handle our exports, is it not essential that immediate action should be taken to secure the required American tonnage? Although each succeeding month has seen an increase in the tonnage under construction for private account, this increase has not been sufficient to compensate for the completion of Shipping Board vessels and the total of the government and private tonnage has decreased.

Now that the Merchant Marine Act has provided for the expenditure of $25,000,000 annually for the next five years to aid the construction of new vessels, has exempted shipowners from the payment of war and excess profit taxes, providing the money is spent in building new vessels, and has in many other ways provided for the welfare of our merchant marine, it is up to us to keep our shipyards busy.

LETTERS TO THE EDITOR

Deflection of Concrete Ships

In the current issue of Marine Engineering, under "Questions and Answers for Marine Engineers," I notice a statement that "no tests have been made to the writer's knowledge upon the deflection of concrete ships."

Although, unfortunately, I have no experience under sea-going conditions to relate, I have made observations on three concrete vessels on launching. These boats were 125 feet long and with sights arranged about 112 feet apart no deflection was observed. A steel vessel under similar conditions would probably have a deflection of 3/16 inch or so.

Bethlehem, Pa. George B. Storey.

[For further information regarding tests on the deflection of concrete ships, readers are referred to the article on "The Strainagraph and Its Application to Concrete Ships," page 588 of this issue.—The Editors.]

Ship's Fire Detection System Performs an Unexpected Task

The crew of the *Leviathan* tell many stories, humorous and otherwise, of their experiences during the many months that vessel was occupied in transporting American troops to and from France. One of their lesser hardships involved their troubles in finding some out-of-the-way nook for their quiet daily smokes, for no smoking was allowed on board.

In one of the lower holds a number of the crew were gathered one evening for a quiet, undetected smoke. But their plans were foiled, and the men, it is supposed, were temporarily reformed by an odd accident. The ship's fire detection system was based on the principle of locating incipient fires by catching traces of smoke which are conveyed through pipe lines to the wheel house. Here, on that particular evening, the officer on duty not only distinctly caught the tobacco odor, but was able by noting the faint wisps of smoke in the fire detecting cabinet to locate the hold, and the men were "caught in the act."

Thereafter when the men sought a hold for their smoking parties they were careful to detail several men to see that each of the smoke collectors in the hold was carefully and completely stopped up with socks, blouses and odd pieces of wearing apparel.

New York. F. S. Titsworth.

Stop the Waste of Fuel Oil

In spite of the repeated requests for conservation of fuel oil due to the constantly increasing demand and the diminishing supply in this country, there is a great waste of this, our most desirable fuel, in the marine boiler plants.

Large numbers of ships lie at anchor in Hampton Roads and at the piers of Portsmouth, Norfolk and Newport News with an excessive and wasteful amount of smoke coming from their stacks. In fact, on some days for hours at a time in the vicinity of the piers adjacent to the Navy Yard at Portsmouth, Va., the smoke from vessels clouds the sky over that section of the city. This condition, which no doubt exists in other ports and also while the ships are at sea, shows that many barrels of oil are being needlessly wasted.

The reasons for this waste are many and can be divided into two classes; first, those due to inefficient boilers, blowers and oil burning outfits, and, second, those due to the lack of experienced operators for the plants. The first class can be considerably reduced by the builders of the ships and the manufacturers of the oil burning apparatus, who should give this subject more attention and make greater efforts to increase the efficiency of their boilers, burners and auxiliaries. The other conditions can be improved by the supervising engineers, who should give more attention to the training of their boiler room personnel. The fact that a great many oil burning ships can steam efficiently and without excessive smoke when in port as well as when at sea shows that the losses of the remaining ships can be materially reduced.

Another source of waste is the large amount of oil that is pumped overboard from oil burning ships. This is not only an economic waste, but it has become a source of annoyance in the harbors and at the bathing beaches. Part of it is due to leaks from the oil systems into the bilges and part to the lack of care in pumping water and sediment from the bottoms of tanks. Both of these wasteful conditions can be almost eliminated with a little care by the operating force.

The conservation of fuel oil should be given careful consideration by all concerned in its use and every effort made to obtain the greatest amount of power that is possible from each pound.

Norfolk, Va. J. M. Moore.

Piecework in British Shipyards

The important subject of piecework in British shipyards is now being seriously discussed by ship constructors' and shipwrights' associations in several British shipbuilding centers. It is recognized that piecework is a possible alternative to the system hitherto in vogue.

In a circular recently published on the subject, after describing the position of the shipwrights since the end of 1919, it is stated that while the berths were enormously increased there was a smaller number of men to cope with the work; also that several districts had adopted piecework since the armistice (November, 1918). The circular states that piecework is now pretty general through the area of the ship constructors' and the shipwrights' associations and draws special attention to the fact that the Federation of Unskilled Men's Unions has also accepted the system of payment by results. At a conference held a few weeks ago between masters and men, the following working conditions were provisionally adopted:

(1) That piecework in the shipwrights' trade is needed in order to cope with the present position in the shipbuilding industry, and it may be assumed that the system will not result in unemployment. In the event of the work slacking off, and should any unemployment result therefrom, the shipwrights reserve to themselves the right to revert to the system in operation prior to the war; they will, however, give reasonable notice to the employers before doing so.

(2) The employers state that they are desirous that in their yards where the piecework system has been adopted there be an equitable distribution of piecework and that every effort will be made to maintain only a minimum number of men on time; in order to be able to do so, the employers' association will recommend its members to fix up prices wherever possible to cover unlisted or obstructed work; moreover, reasonable allowance shall be made in cases where men are adversely affected by unforeseen and unusual obstructions.

The men's circular states, as regards clause (1) quoted above, that it absolutely guarantees the shipwrights

against the fear of unemployment arising out of the system of piecework and that the men reserve to themselves the right, which is now recognized and accepted by the employers, to revert to the previous system after due notice should the occasion (that is, unemployment) arise. Clause (2) does away with any favoritism or any faddiness of the foreman and concedes a principle which has been the subject of strife for many years.

Manchester, England. T. SINGTON.

How Long Should a Vessel Stay in Port for Discharging and Loading Cargo?

Although it is of greater interest to know the necessary time for discharging and loading miscellaneous cargoes, yet the actual time consumed for bulk freight can also be of practical service, especially if representing a record of minimum time. The following figures are from official records:

For ore unloading on May 11, 1918, at Gary, Ind., 11,415 gross tons were taken out of the steamer *Wm. B. Dickson* in 4 hours 10 minutes, an average of 2,739 tons an hour.

On July 9-10, 1918, the steamer *G. G. Barnum,* with 10,610 net tons of coal, was unloaded, shifted to another dock and loaded with 9,767 tons of ore in 16 hours. During this time of 16 hours there were discharged and loaded 21,549 net tons of freight.

The minimum average time spent in the upper and lower Great Lakes ports by one fleet of ships will indicate what has been done in 1918: Average time spent in port receiving and discharging cargoes at upper and lower lake ports, 31 hours 26 minutes; average cargo, 8,498 gross tons; largest cargo carried, 13,505 gross tons; fastest loading record, 12,655 gross tons in 1 hour 50 minutes; fastest rate per hour, 6,903 gross tons.

The figures in general apply to loading and discharging coal and then loading and discharging iron ore. Until the official records were made the possibility was doubtful.

For miscellaneous cargoes, utilizing the combined gantry cranes and ships' winches for transferring between vessel and shore and overhead conveyors to secure a steady flow of the cargoes through the transit sheds, including assorting, distributing and tiering, it should be possible to attain far superior results than have been possible in the past.

The later method of operation has been for the ships' winches, at least two winches at each hatch, preferably four, to raise the draft from between decks and then above the upper deck, when the load is burtoned to the hook of the gantry crane (there should be two cranes operating at each hatch), and then swung just within the shed. With five hatches to a ship there would be ten winches and ten cranes operating simultaneously.

As sixty drafts per hour can be raised from each hatch, and averaging one ton per draft per consignment, then from five hatches there should be not less than 300 tons per hour, or in ten hours three thousand tons per day in discharging. This is possible, as the cycle of the winches and of the cranes is less than if there was not a division of the work.

For miscellaneous cargoes the flow through the shed is kept continually moving without congestion. This is effected by a combination of overhead traveling cranes and overhead traveling hoists. The number of traveling hoists is proportioned to the volume of the freight and to the number of consignments. To discharge a ship of an average capacity of 4,500 tons would require only fifteen hours.

For loading the ship the gantry crane swings the load to the bottom of the hold or to the required deck and the function of the ship's winch is to drag it to its stowage place between decks. This is far below the figures for handling bulk freight, which can probably never be equalled when handling miscellaneous freight.

More freight can be loaded than discharged in the same time, and 375 tons per hour are here possible, especially if there are more winches. This freight, however, must be brought by the overhead internal crane machinery to within reach of the hook of the gantry crane, so that there may be no waiting or congestion points.

To discharge 4,500 tons of miscellaneous freight would require twelve hours. It would, however, be better to have three shifts of eight hours each, and then the ships would be discharged in about two shifts and in one and one-half shifts.

If there could be four winches to a hatch, then additional speed could be secured by discharging upon or loading from lighters. The freight movements would be upon both sides of the ship simultaneously.

The bunkering or the taking on of the fuel oil can be done during the transferring of the cargo.

Four thousand five hundred tons inbound and 4,500 tons outbound should require a little less than 30 hours for discharging and for loading, repairs to be performed as usual during this time.

The above figures are possible but require a high efficiency of the winches and cranes and no congestion or interruption of the flow of the freight. There is not sufficient floor area alongside the ship, and overhead unoccupied air spaces must be utilized. It is only by careful designing of all the terminal elements and a complete co-ordination of all the movements of the freight by mechanical appliances that such results can be attained. One congestion point will greatly reduce the above figures.

New York. H. McL. HARDING,
Consulting Terminal Engineer.

British Committee on Inland Waterways

The Minister of Transport of Great Britain announces the appointment of the following committee on inland waterways: Neville Chamberlain, M. P., chairman; W. M. Acworth; R. B. Dunwoody, O. B. E., A. M. Inst. C. E., F. R. G. S.; Sir John E. Eaglesome, K. C. M. G.; Sir Noel T. Kershaw, K. C. B.; C. F. H. Leslie; Sir Halford J. Mackinder, M. P., and Arthur Sharp, secretary.

This committee is to investigate the following questions:

(1) What portions, if any, of the inland waterway system of the country should be acquired by the Ministry of Transport with a view to improvement and upon what terms?

(2) What should be the form of ownership of such acquired portions; whether under the State, through a department of the Ministry of Transport, or through a regional trust or by any other method? If a trust be recommended, what should be its constitution and the nature of its governing body?

(3) What improvement should be carried out in such acquired portions? What would be the cost of the improvement and how should the necessary funds be raised? Whether such acquired or improved portions would become self-supporting, and if not, what deficit would be involved; also what indirect advantage would be obtained to compensate therefor?

(4) What method should be adopted to ensure that any improvement in the value of the frontages should be secured in part at least to the body carrying out the improvement to the waterway?

(5) In what manner could co-operation best be developed between transport by water and transport by rail or road?

NEW BOOKS

Naval Architects' Data

REVIEWED BY C. H. PEABODY, DR. ENG.

NAVAL ARCHITECTS' DATA. By J. Mitchell, M. I. N. A. Edited by E. L. Attwood, O. B. E., M. I. N. A. Size, 5½ by 8½ inches. Pages, 224. New York, 1919: Longmans, Green & Company. Price, $3.

This book provides printed forms for recording data for fifty ships.

The author is a shipyard manager and the editor is a well-known writer on naval architecture. Working together they have made a convenient form for recording data. They provide also the proper constants, factors and methods of computation and apply them to a particular case. At the back of the book are convenient tables of logarithms, squares, cubes and roots and areas of circles. Perhaps in a later edition they may find it possible to make a loose-leaf book, with provision for making changes and rearrangements.

Ship Stability and Trim

REVIEWED BY C. H. PEABODY, DR. ENG.

SHIP STABILITY AND TRIM. By Percy A. Hillhouse, B. Sc., M. I. N. A. Size, 5½ by 8½ inches. Pages, 297. Illustrations, 203. New York, 1919: D. Van Nostrand Company. Price, $4.50.

The author gives as the object of this book the presentation of the problems of stability of a ship more freely than is possible in any general text-book on naval architecture, and at the same time more simply than those books, avoiding mathematical methods. He hopes to meet the needs of those preparing for examinations for masters by the British Board of Trade. He says that if the master of every vessel were to make a point of carefully estimating the stability of his vessel at the beginning, during and at the end of every voyage, of utilizing this information as a guide to the correct use or avoidance of water ballast, and if he also habitually studied the behavior of his vessel at sea in the light of his knowledge of her stability factors, he would very quickly amass a quantity of data which would be a valuable aid to himself in the handling of his vessel, and of great use to the builders when projecting a new vessel for the same or a similar service. Many shipmasters have for years been in the habit of making such calculations. Also attention is called to the necessity that the master should note and correctly interpret the signs of decreasing stability, due to consumption of fuel or otherwise, as shown by inclination due to wind pressure or by slowing and sluggishness of rolling.

It is most encouraging to know that some shipmasters have such ability and use it; it is unquestionably desirable that all masters of modern ships should have the ability to apprehend the main features of stability and their relation to the movements of the ship. The author is correct in his opinion that abstruse and academic investigations are not for a shipmaster; in fact, we may go further and say that if he knows the properties and phenomena as facts he need not too much concern himself with the geometrical principles behind them.

It may be desirable to have a book presenting the facts concerning stability and rolling of ships simply and even dogmatically; it is certain that such a book has not been written. A shipmaster of studious habit may inform himself on these matters from any one of the simpler books on theoretical naval architecture; perhaps this book may be useful for that purpose, but it appears to contain much that is not needed by the shipmaster, and it is feared that certain parts may even be confusing.

Like almost all British writers on stability, the author endeavors to lead up to the stability of a ship by dealing first with simpler forms like cylinders and prisms; but the essential features of stability of a ship can be simply and clearly shown without such an introduction; in fact, we advise the reader of this book to omit the preliminaries and turn at once to the discussion for a ship which is stated clearly enough.

The most interesting chapters of the book are those on the effect of wind pressure and of trim during docking. Both are clearly and directly stated. The first is interesting to the shipmaster, especially if he chances to command a high-sided tender ship. But docking is the province of the dockmaster, and is equally interesting to the naval architect. Perhaps, however, the master of a ship may sometimes need to look after docking, especially in remote quarters of the earth.

In his chapter on free water in the ship, the author calls attention to the danger that may come from flooding side compartments, whether side bunkers or oil tanks. It is unlikely that flooding such a compartment will immediately capsize a ship, but the stability after the flooding may be dangerously small and especially the range of stability may be meager. The author also gives with some particularity methods of determining the position of the center of gravity by aid of an inclining experiment, together with examples in detail.

Hydrography

PHYSICAL LAWS UNDERLYING THE SCALE OF A SOUNDING TUBE. By Walter D. Lambert. Size, 5¾ by 9 inches. Pages, 45. Illustrations, 2. Washington, D. C., 1920: Government Printing Office. Price, 5 cents.

The use of the sounding tube or depth recorder has long been recognized as a convenient and rapid method for getting approximate soundings in depths of 100 fathoms or less. It has never been an instrument for accurate surveying and, indeed, the depths shown by two tubes of different patterns, thrown overboard at the same point, or even by two tubes of the same pattern, have often exhibited surprising discrepancies. The larger discrepancies must be due to some accident in the working of the apparatus, but the smaller ones may be due to the different assumptions made in laying off the scale of depths used. Moreover, it does not appear that the method of graduating the tubes now on the market has ever been published in detail.

It is the purpose of this paper: (1) to provide, with the information at hand, as correct a scale as possible for the tubes of the new Coast and Geodetic Survey pattern; (2) to give a method for correcting the depths read directly from the scale for variation in temperature and in atmospheric pressure; (3) to provide a compilation of physical data likely to prove convenient in a further study of the subject.

An approximate formula is first derived and corrections are given for the departure of the air from a perfect gas and for the vapor pressure and the compressibility of water; the final formula is put in a convenient form for computing tables from it. The tables at the end contain a compilation of data on the physical properties of air and sea water. The use of some of the tables is illustrated by numerical examples.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

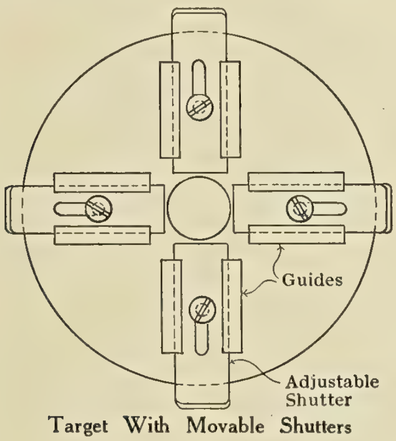
This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Locating Shafting Line

Q. (1047).—Will you kindly describe the best method of setting line for boring out stern frame for tube, also checking up the sag in line.
B. F.

A. (1047).—There are several methods of setting up mark for boring out the stern frame for stern tube. One method, in which an engineer's level was used, is very clearly described by Mr. T. A. Johnson in MARINE ENGINEERING, April, 1920, page 378.

The use of the line of sight method (ray of light) is described in "Engine Room Practice" by John G. Liversedge. Briefly, it consists of a light with a reflector placed ahead of the main engine location, and at the proposed height of the shafting. At the forward end of the main engine a thin screen with a small hole (about 1/32 inch diameter) is placed, the hole being at the desired position of the shaft centerline. At the aft end of the stern post



Target With Movable Shutters

a similar screen should be fitted at the correct location of the shaft center. These two screens, with the holes in, together with the light, give a ray of light which defines the centerline of the shafting. To get any intermediate position of this centerline it is convenient to use a target having movable shutters (similar to the one in the figure) clamped to a temporary wooden upright set at the desired fore and aft place. The work of sighting and finding the position of the shaft center can best be done at night with any extra lights curtained off.

If a steel wire is used it will be necessary to allow for its sag, which for great distances may be considerable. A table for the sag of a piano wire of different spans and at various points is given in *The American Machinists' Handbook* (1914 Edition, page 429). A description of an experiment to determine the sag, together with curves of same, is given in the *Journal of American Society of Marine Draftsmen,* October, 1914.

Substitution of Radial for Feathering Paddle Wheels

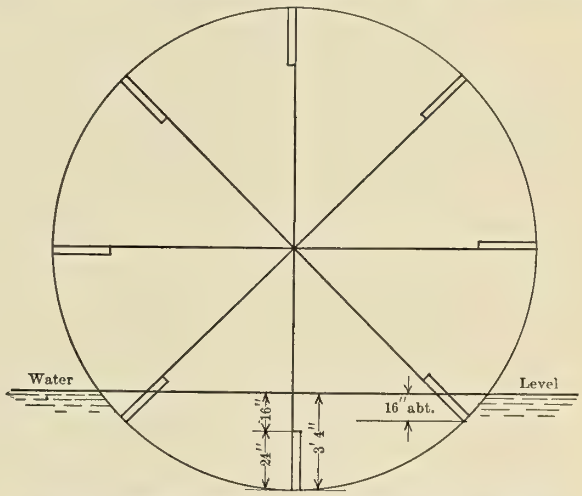
Q. (1050).—Can the speed of a ferryboat be improved by substituting a fixed type of bucket for the feathering type which it now has? The theory of the engineer is that there are not enough buckets in the water; also that the buckets run too far below the surface of the water, causing the engines to labor. His idea is to increase the number of buckets, reduce their width and "break step" in the buckets. By breaking step he means that each float or bucket will not run the full width of the wheel. Following is the data:

A side wheel ferryboat propelled by two 16-inch by 6-foot simple condensing engines making 31-32 revolutions per minute on 245 pounds steam, cutting off at 2 feet, or one-third stroke. Side wheels are 16 feet in diameter, each having eight buckets 6 feet long by 2 feet wide.

Three buckets only are in the water and their depth and position are explained in the sketch. The ferry is double ended. When the feathering mechanism is behind or opposite that in which the boat is running, the boat makes her best time. When it faces the direction in which the boat is running, it requires three minutes longer on a 15-minute trip. As the main shaft is just beneath the deck, it is not practicable to increase the diameter of the wheels, and vehicles forbid raising it above the deck. If the feathering mechanism were discarded, 16 inches or 18 inches could be added to the length of the buckets, making them 7 feet 4 inches or 7½ feet in length. Hence the two flexible factors in a wheel change seem to be the length of the buckets and their immersion.

When running, there is a slight rocking of the boat from side to side, which would indicate that the engines are laboring and that power is being absorbed uselessly in some sort of lifting action at the buckets during each revolution. What suggestion or solution would you offer to improve the problem?
A. H. C.

A. (1050).—There appears to be but little data or information concerning feathering paddle wheel ferry steamers or radial paddle steamers. It would be well



Approximate Position of Floats on Feathering Paddle Wheel. Diameter of Wheel, 17 Feet; Each Float, 24 Inches Wide by 6 Feet Long; Draft of Boat, 4 Feet 10 Inches

perhaps first to consider whether the present installation is well proportioned for going ahead. You complain of laboring or vibration. This is likely to occur with the present wheels, as they do not have many blades compared to wheels of larger diameter. Below, the area, number of floats, dimension and immersion of blade for a feathering paddle wheel of this type have been worked out according to formulae from Seaton and Rounthwaite's *Pocketbook of Marine Engineering Rules and Tables.* An indicated horsepower of 400 and a slip of 20 percent have been assumed, as, unfortunately, your data do not give the ferry's speed, horsepower, molded dimensions, displacement, de-

tails of feathering mechanism, and, further, there appears to be a mistake in the steam pressure given.

Area of one blade =

$$\frac{I.H.P.}{f-f^2} \times \left(\frac{83.2}{D \times R}\right)^3 = 14.23 \text{ square feet} \qquad (12.0)$$

$$\text{Number of floats} = \frac{D+2}{2} = \frac{15+2}{2} = 8.5 \qquad (8)$$

$$\text{Breadth of float} = \sqrt{\frac{A}{2.8}} = 2 \text{ feet } 3 \text{ inches} \qquad (2 \text{ feet})$$

Length of float = 2.85 × breadth = 6 feet 3 inches (6 feet)

Immersion varies from ⅛ (breadth) = 3½ inches
to ½ (breadth) = 13½ inches
(16 inches)

where

D = diameter to float centers.
R = R. P. M.

$$f = \frac{V-v}{V}.$$

V = peripheral speed, feet per second, of wheel.
v = speed of ship, feet per second.
A = area of float.

The figures in the parentheses indicate the present feathering wheel dimensions. From the above you will see that the present wheel agrees reasonably well with correct proportions based on our assumptions for indicated horsepower, etc. The only improvement would be to decrease the vibration by increasing the number of blades and possibly to decrease the immersion slightly. Undoubtedly the use of radial wheels with the blades "breaking step," i. e., each blade to be only half the wheel length, would greatly reduce laboring or vibration.

The *Baystate* is an example of a vessel having both radial and feathering wheels during her existence. The feathering wheels were 22 feet 7 inches to centers of gudgeons and were driven at 20 revolutions per minute; the radial were 35 feet overall and turned up about 16 revolutions per minute (notice that the peripheral speed was about the same for each case). A few instances of ferries with both types of wheels are here given:

Ramona (see Marine Engineering, 1903, page 625)

Hull Dimensions.—Length overall, 130 feet; length between perpendiculars, 118 feet; beam (hull), 29 feet; beam (over guards), 49 feet; depth, 13 feet 9 inches.

Machinery.—Two cylinder, high pressure engine; 20 inches diameter by 72 inches stroke; indicated horsepower, 670; boiler pressure, 150 pounds; revolutions per minute, 35; speed, 12.5 knots.

Paddle Wheel (Radial Type).—17 feet diameter; 18 floats 18 inches wide, 6 feet long; immersed 12 inches.

Passenger Ferry (Data Approximate)

Hull Dimensions.—Length overall, 150 feet; beam (hull), 30 feet; beam (over guards), 50 feet.

Machinery.—Jet condensing beam engine with cylinder; 38 inches diameter by 96 inches stroke; indicated horsepower (nominal), 500; boiler pressure, 52 pounds.

Paddle Wheels (Break Step Type).—18 feet diameter; each half blade 4 feet 3 inches long; number of half blades = 2 × 14 each wheel; width of blade, 20 inches; immersion, 20 inches; speed, 9½ knots at 28 revolutions per minute and 39 pounds boiler pressure.

San Pedro (see Marine Engineering, 1911, page 345)

Hull.—Length between perpendiculars, 248 feet 6 inches; beam (hull), 36 feet.

Engine.—Inclined compound, 38 inches by 77 inches by 66 inches; indicated horsepower, 2,000.

Paddle Wheels (Feathering Type).—16 feet diameter to center of floats; number of blades, 8, each 3 feet 6 inches wide, 10 feet long.

Colonel Stevens, in Marine Engineering for 1897, refers to two feathering wheel ferries in use in New York harbor, the *Garrett* and *Winnan*, which had paddle wheels 17 feet in diameter, adjusted so that full advantage of the feathering principle was not taken (probably to allow for the poor efficiency when running astern).

The only published model experiments known to the writer on paddle wheels were those made at the instance of a committee of army engineers studying the question of river towboats. These are reported with numerous curves and interesting data in *Experimental Towboats*, House of Representatives Document 857. Many of the conclusions regarding these experiments as affecting feathering paddle wheels have been given in a paper by Professor E. M. Bragg before the Society of Naval Architects and Marine Engineers (1916). Some of their findings are here quoted:

"1. Thrust increases with immersion for any slip.

"2. Efficiency decreases rapidly with higher slip, also with greater immersion.

"3. Thrust increases with number of floats within usual limits.

"4. Effect of increased width of blade is small at small immersions, but at deeper immersions wider blades give greater thrust.

"5. Efficiency decreases slightly with number of floats.

"6. Thrust varies approximately as length of float.

"7. When two wheels are separated, the thrust, except when very close, is that due to two wheels only.

"8. Thrust varies approximately as the diameter for constant immersion.

"9. For a given diameter and immersion the radial delivers more thrust than the feathering, but at a smaller efficiency.

"10. The thrust and efficiency of a feathering wheel vary with the position of the feathering eccentric, the thrust generally decreasing with increase of eccentricity."

Furthermore, the maximum efficiency of the feathering paddle wheel is about 5 percent greater than the maximum efficiency of the radial.

The writer has taken the present feathering wheel, assumed a wake and slip, and from the data given found the thrust and efficiency of this wheel. A radial wheel of the same overall diameter and a length of 7 feet 6 inches, as suggested in the question, to give the same thrust would have an efficiency about 12 percent less than the feathering wheel. In other words, if radial wheels were installed 17 feet overall diameter and about 28 half blades (stepped type) to each wheel, the engine would have to work at roughly 18 percent greater power to produce the go-ahead speed of the present installation. However, if the power remains the same, the speed with radial wheels would be 6 percent less than the ahead speed with feathering (assuming that power varies as V^3). According to your figures, going astern the speed with feathering wheels is 20 percent less than ahead. If we take the speed with radial wheels as 6 percent less than feathering going ahead, installing radial wheels would give a gain of about 4 percent over the average speed made by the feathering wheels.

Although the writer has never heard of its being done, why not arrange the outer bearing of the feathering mechanism so that it may be rotated from a position forward of the shaft center to one aft for going astern. This would make the efficiency going astern equal to that ahead, provided the floats are straight and not curved. However, the complication of such a mechanism might prevent its adoption.

"Some Data on Paddle Wheel Steamers," by C. A. Anderson, Marine Engineering, 1910, page 445, gives some very interesting data on this subject.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

HANDICAPS ON SHIPBUILDING MAY BE OFFSET BY NEW MEASURE

Shipping Bill Provides Means For Overcoming Serious Disadvantages and Placing Our Merchant Marine on a Firm Foundation

So rapidly is the Shipping Board's programme drawing to completion that more tonnage is now under construction in American shipyards for private account than for the Government, says a statement just issued by the Atlantic Coast Shipbuilders' Association. Building for private account took the lead in April, and now holds it by 325,000 gross tons.

Construction records prepared by the association date back to last October, when the shipyards began to be engaged to an appreciable extent on orders for private account. How the totals of Government and private building have compared since that time, and how the excess of Government construction has been steadily pared down are shown in the following table, giving the construction under way in gross tons:

1919	Shipping Board	Private Orders	Governm't Tonnage Lead
October	2,600,146	347,343	2,252,803
November	2,300,380	550,714	1,749,666
December	2,095,308	805,147	1,290,161
1920			
January	1,975,000	977,488	997,512
February	1,829,284	1,256,573	572,711
March	1,629,228	1,337,445	291,783
			Private Tonnage Lead
April	1,311,623	1,404,198	92,575
May	1,140,683	1,466,324	325,641

How the construction since last September has shown a widening gap from the totals for the same months of a year previously is seen in the following comparisons. During the late months of 1918 and the early ones of 1919 practically everything under construction was for the Government, while in the later months private contracts were being carried out on a growing scale in addition to those for the Shipping Board. The figures given are in gross tons:

	1918	1919	Decline from Previous Year
October	3,260,000	2,947,489	312,511
November	3,333,246	2,851,094	482,152
December	3,419,140	2,900,455	518,685
1919		1920	
January	3,537,836	2,952,488	585,348
February	3,592,438	3,085,857	506,581
March	3,733,132	2,966,673	766,459
April	3,727,240	2,715,821	1,011,419
May	3,584,962	2,607,007	977,955

The manner in which gains in orders for private account for a time counterbalanced the excess of Shipping Board deliveries over new keels laid is indicated by the following table showing gains or losses in comparison with the previous month to the one given, the figures given in gross tons:

1919	Shipping Board	Private Orders	Total Gain or Loss
November	—299,766	+203,371	—96,395
December	—205,072	+254,433	+49,361
1920			
January	—120,308	+172,341	+52,033
February	—145,716	+279,085	+133,369
March	—200,056	+80,872	—119,184
April	—317,605	+66,753	—250,852
May	—170,940	+62,126	—108,814

+ Increase. — Decrease.

America now has been definitely passed by Great Britain in the amount of tonnage building, as shown by contrast with the British totals given in the quarterly returns of Lloyd's Register of Shipping, thus:

	British	American	American Lead
Sept. 30, '19.	2,816,000	3,470,000	654,000
			British Lead
Dec. 31, '19.	2,994,000	2,900,000	95,000
Mar. 31, '20.	3,394,000	2,996,000	398,000

American shipbuilders to-day head the world in quality of output and in facilities for production, as well as in speed of construction, but higher labor costs and unfavorable international exchange are handicaps that must be offset by wise application of the new Shipping Bill signed by the President on June 5. It is imperative that a new Shipping Board, as provided by this law, should be immediately appointed and this board should be of such caliber as to assure the respect and confidence of the American public. They will find in the Greene-Jones Shipping Bill all of the authority necessary to protect our shipping and shipbuilding industries and to secure for the American people their position on the high seas, which is so ably defined in the preamble of the Shipping Bill. This preamble states:

"That it is necessary for the national defense and for the proper growth of our foreign and domestic commerce that the United States shall have an American Merchant Marine of the best equipped and most suitable type of ships sufficient to carry the greater portion of its commerce and serve as a naval or military auxiliary in time of war or national emergency, ultimately to be owned and operated privately by American citizens; and it is hereby declared to be the policy of the United States to do whatever may be necessary to develop and encourage the maintenance of such a marine."

Dratfsmen Hold Convention

The ninth annual convention of the American Society of Marine Draftsmen met at the Hotel Harrington, Washington, D. C., June 18 and 19. Representatives from the eleven branches of the society were present. Several amendments to the constitution were adopted, the most important of which relate to the membership. Former associates become associate members, and provision is made for extending the privilege of membership in the society, as associates, to men over twenty-five years of age who hold positions of responsibility in the manufacture or sale of marine equipment or the operation of ships. Co-operation between the manufacturers of equipment and the men who plan its installation in the shipyard and aboard ship is of mutual advantage, and this fact has been recognized by other well-known technical societies. Another amendment provides for the admission of men of eighteen years of age to membership as juniors, who are students in naval architecture or marine engineering at a recognized technical school.

Officers elected for the coming year are as follows: C. E. Deiser, president; E. H. Monroe, vice-president; B. G. Barnes, secretary; J. B. Sadler, treasurer; A. H. Haag, the retiring president, member of executive committee.

Two able and instructive papers were presented, "Notes on Preliminary Design," by J. L. Bates, who is in charge of that work at the Bureau of Construction and Repair, was a very clear explanation of the value of this work and the extent to which it has been developed in the Navy Department; "Joiner Work, Its Relation To and Use in Shipbuilding," by C. J. Early, of the Bethlehem Shipbuilding Corporation, was particularly interesting, as very little literature on this subject is available.

On Friday evening the convention enjoyed a moonlight excursion on the Potomac. On Saturday evening a banquet was given, at which speeches on Americanism, shipbuilding and the future of the society were enthusiastically received.

E. H. Monroe as toastmaster *was there* with his stories and mimicry. A. H. Haag delivered an able speech on "Americanism," which started a feeling of enthusiasm which grew during the evening, and reached a climax when J. B. Sadler spoke on the future of the society.

ABROGATION OF TREATIES NOT NECESSARY

New Shipping Bill Takes Advantage of Underwood Tariff Act

There is a widespread misconception as to the effect of the Shipping Act of 1920 upon the commercial treaties of the United States with other nations, says a statement issued by the Atlantic Coast Shipbuilders' Association. The general opinion seems to be that the provision for the termination of certain specified stipulations of the treaties is merely a step that paves the way to taking action that will benefit the shipping of the United States. Enforcement of a policy favoring our own vessels over those of foreign countries is regarded as optional, and the enactment of additional legislation to apply the principle of discrimination to the advantage of the American merchant marine is, in the public mind, a necessity.

All these opinions are erroneous. Through the forces created by the enactment of the bill there will automatically be set in motion machinery constructed with a view to the likelihood of the termination of the treaty provision.

A prevalent misconception in connection with the bill is the belief that it requires the abrogation of our commercial treaties. No such step is necessary. Not abrogation of the agreements, but modification of some of the terms is provided for, and automatically brings into play certain provisions of the Underwood Tariff Act of October 3, 1913. These are contained in Section IV of the Act, and are specifically stated in subsections 1, 2-3 and 7. By these sub-sections discriminations in favor of American shipping are provided—except in cases where treaty agreements with foreign nations specifically provide against such discrimination.

Through the operation of Section 34 of the Shipping Act of 1920, the termination of the treaty provisions against discriminations in regard to shipping are provided for, and at the end of the necessary period of notification the indicated provisions of the Underwood Tariff Act are brought into action, as follows:

A 10 percent duty ad valorem is imposed on all imports in vessels not of the United States. All imports by water are forbidden, except in American vessels or vessels belonging to the country from which the imports originate, but this does not apply in cases where nations do not maintain a similar regulation against United States vessels. A 5 percent discount is allowed on all duties on goods imported in American ships.

32 NEW SHIPPING COMPANIES FORMED IN MAY EQUALS RECORD

Capital of $31,983,000 Much Less Than in Preceding Months, But Big Increase Over May, 1919

New shipping enterprises during May included the formation of 32 companies, with an aggregate authorized capital of $31,983,00. In the number of concerns launched the month's activity equaled the top mark so far this year, established in January, but capitalization figures were the smallest for any month to date in 1920. The indicated investment shows a marked drop as compared with April, when the record of $178,835,000, chiefly due to the inclusion in the list of one large company, was set for the Journal of Commerce compilation, which has been maintained since the outbreak of the war in 1914. The May total, however, stands well ahead of that for the corresponding month of last year, $17,200,000. Only concerns with an authorized capital of $50,000 or greater are listed in the compilation.

For the first five months of the current year the records show a total indicated investment of $382,353,000, which is more than $50,000,000 ahead of the aggregate for the entire twelve months of 1919. During January-May a year ago the total rolled up was only $42,801,000. On the basis of these figures the average monthly indicated investment so far this year appears as $76,470,600, compared with $8,560,200 for the corresponding months of 1919, and with $26,967,750 for the entire year 1919.

The average indicated investment per company for May figures out as $999,469. This is the lowest average for any month so far this year, comparing with $8,128,864 in April, $2,945,237 in March, $1,963,530 in February and $2,384,531 in January. The average per company for the first five months of the year appears as $3,083,490, a figure which demonstrates the importance of the new units in shipping enterprise that have sprung up this year. Actually 57 companies of the 124 organized have an authorized capital of $1,000,000 or greater, which is regarded as a reasonably large proportion.

The indicated investment in new shipping enterprise during the periods indicated is shown in the following table:

August-December, 1914	$1,844,000
Year 1915	37,062,000
Year 1916	$69,466,000
Year 1917	271,503,000
Year 1918	120,353,000
Year 1919—	
January	7,525,000
February	6,400,000
March	9,276,000
April	2,400,000
May	17,200,000
June	55,550,000
July	42,485,000
August	55,950,000
September	40,870,000
October	23,405,000
November	52,700,000
December	10,362,500
Total	$323,613,000
Year 1920—	
January	$76,305,000
February	33,380,000
March	61,850,000
April	178,835,000
May	31,983,000
Total, five months, 1920	$382,353,000

More companies with an authorized capital of $1,000,000 or greater were organized in May than in any previous month of the year, notwithstanding that the May total is the smallest to date in 1920. The number of concerns of such proportions incorporated in the month was 15, compared with 13 in April, 12 in March, 7 in February and 10 in January.

The following list gives the names, state of incorporation and authorized capital of shipping companies organized in May:

Arapahoe Navigation Co., Dela.	$275,000
Bee Line Transportation Co., Dela.	2,000,000
Baltic Steamship Corp., N. Y.	500,000
Cummins-McDonald Navigation Co., Dela.	50,000
Casco Bay Lines, Me.	75,000
F. A. S. Line, Inc., The, Dela.	250,000
First National Steamship Co., Dela.	600,000
International Transportation Co., Dela.	1,000,000
Luckenbach Terminals, Inc., N. J.	2,000,000
Muscoota Navigation Co., Dela.	400,000
Mercantile Lines, Inc., Dela.	500,000
Mount Shasta Steamship Co.	1,556,600
Neptune Shipping Corp., N. Y.	200,000
Nyanza Steamship Co., Ltd., Dela.	1,000,000
Pacific Motorship Co., Dela.	3,250,000
Paragon Navigation Corp., Dela.	100,000
Pitt Navigation Co., Dela.	51,000
Rhode Island Steamboat & Lightering Co., R. I.	100,000
Steamship & Shipyard Equipment Corp., Dela.	100,000
Spindrift Shipping Corp., N. Y.	80,000
Tonawanda Navigation Co., Dela.	275,000
Talbot Steamship Co., Dela.	2,200,000
Unsinkable Boat Co., The, Dela.	2,000,000
U. S. Mail Steamship Co., N. Y.	200,000
U. S. Ocean Services, Inc., N. Y.	1,000,000
Willsolo Steamship Co., Dela.	2,200,000
Western Steamship Co., Dela.	500,000
Westbrook Steamship Co., Dela.	1,857,600
Willhilo Steamship Co., Dela.	2,910,000
Willfero Steamship Co., Dela.	1,000,000
Westlake Steamship Co., Dela.	1,837,800
Yellowstone Steamship Co., Dela.	2,225,000
Total	$31,983,000

Oiler Adapted to Marine Uses

A new type of oiler has been developed by the National Marine Lamp Company, Forestville, Conn. This oiler is well adapted to marine uses. Special features include an interchangeable spout, a spring check valve, a filler hole having an eccentric revolving cap. The fact that the spout is detachable and so may be renewed insures long service from the oiler. Complete data on various types of orders will be supplied on request.

RULES FOR MOTORSHIPS

American Bureau of Shipping to Frame New Regulations

Largely through the efforts of Captain C. A. McAllister, vice-president of the American Bureau of Shipping, representatives of American companies engaged either in the production of internal combustion engines or motorships met in conference on June 7 at the offices of the American Bureau of Shipping, 66 Beaver street, New York, for the purpose of formulating and adopting new rules for the survey and classification of motorships.

The following were present: Dr. Charles E. Lucke and W. B. Jennings, Worthington Pump & Machinery Company; Robert Warriner, Bethlehem Shipbuilding Corporation; D. W. Armstead, Bethlehem Steel Company; J. A. Seymour and Harte Cooke, McIntosh-Seymour Corporation; Max Rotter and George D. Pogue, Busch-Sulzer Company; James Craig, Craig Engine & Machine Works; Charles F. Bailey and John F. Nichols, Newport News Shipbuilding Company; Mr. Schilling, Scandia-Pacific Oil Engine Company; C. B. Edwards, New York Shipbuilding Company; L. N. Wheelock, Boston (141 Milk street); Mr. Anderson, New London Ship & Engine Building Company; E. A. Thomee, Bolinders Company; H. C. Verhey, consulting engineer; T. O. Lisle, editor, *Motorship;* F. B. Webster, editor, MARINE ENGINEERING; Chas. A. McAllister, vice-president, E. G. Tuck, chief surveyor, and Joseph Hecking, engineering staff, American Bureau of Shipping.

A telegram was received from Wm. Cramp & Sons expressing regret at the unavoidable absence of their representative, and letters, displaying keen interest and promising co-operation, were received from the following: Opposed Piston Oil Engine Company, August Mietz Corporation, Nordberg Manufacturing Company, Dow Pump & Diesel Engine Company, J. C. Rolph, Standard Oil Company.

Captain McAllister opened the meeting at 10:15 A. M., and after explaining in short the object of the conference, relinquished the chair to Mr. Hecking, of the Bureau's engineering staff.

Insurance rates for motorships quoted by Mr. Stevens, of the Marine Office of America, showed that the rates for wooden vessels without engines were less than for those fitted with engines, and that the rates for steel vessels fitted with Diesel engines were higher than for those fitted with reciprocating engines. While it was the opinion of those present that the fire hazard on Diesel propelled ships is over-rated, and that the insurance rates are discriminating against Diesel installations, it appeared to be the opinion of the builders that the requirements for Diesel installations should be expanded, without placing any undue restrictions on the designer, for the protection of the experienced and reliable builders, as a check upon any new and untested designs and for the safety of the engines and vessels.

Such questions as testing materials and cylinders, proper size of crankshaft, requirements for pumps and auxiliaries, lubrication, circulation of water, etc., were discussed at length, and it was decided to appoint a sub-committee to cooperate with the Bureau's engineering staff in formulating rules to be submitted to the manufacturers for approval and adoption. This advisory committee is composed of the following:

Dr. Charles E. Lucke, chairman, Worthington Pump & Machinery Company, 115 Broadway; Arthur West, Bethlehem Steel Corporation, Bethlehem, Pa.; Bruno Nordberg, Nordberg Manufacturing Company, Milwaukee, Wis.; Harte Cooke, McIntosh-Seymour Corporation, Auburn, N. Y.; John F. Nichols, Newport News Shipbuilding Company, Newport News, Va.

As Admiral W. S. Benson has given his endorsement to the motorship, and as Congress has appropriated $25,000,000 annually to loan to steamship companies for the construction of vessels powered with the most economical, efficient and modern type of machinery, it is predicted that an era of motorship construction is about to commence. In any case it is fortunate that the Bureau has secured the co-operation of the manufacturers in formulating its classification requirements for motorships.

Allan E. Goodhue Promoted

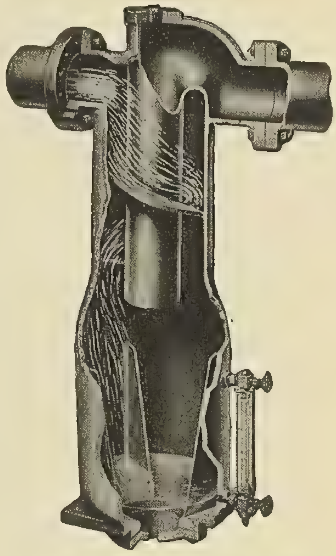
The Chicago Pneumatic Tool Company, New York, announces the election of Allan E. Goodhue as vice-president in charge of sales. Mr. Goodhue, since May 1, 1919, has been managing director of the company's English subsidiary, the Consolidated Pneumatic Tool Company, London, England, also director of European sales for the Chicago Pneumatic Tool Company.

Allan E. Goodhue

Mr. Goodhue was formerly for a number of years connected with the sales department of the Midvale Steel Company and Midvale Steel & Ordnance Company, in Philadelphia, Chicago and Boston, leaving that company in March, 1918, to enter the service of the Government. From that time until January 1, 1919, when he became connected with the Chicago Pneumatic Tool Company, he was assistant manager of the steel and raw material section, Production Division, of the Emergency Fleet Corporation. Mr. Goodhue returns from Europe in time to permit assuming his new duties early in July.

Steam Separators

The Stratton steam separator, produced by the Griscom-Russell Company, 90 West Street, New York, has been developed for the purpose of freeing the pipes and fittings of steam power installations of all moisture. It is designed to prevent all scale, grit, broken tools, as well as moisture, from entering either the engine or the turbine. A collecting chamber of the separator performs the function of a cushion for the pulsations of the steam, and serves to take care of sudden variations in load.



The Stratton Steam Separator

The separator employs the centrifugal principle for separating entrained water from the steam. As the steam and water enter the device they pass through a helical path formed about a central cylinder. The high velocity of the incoming steam and water causes the entire mass to whirl as it passes from the helical channel into the main body of the separator. Water, being many times heavier than the steam, does not follow the turn so easily, but is thrown out of the whirling current of steam by centrifugal force. The path is so proportioned that the particles of water as they leave the steam current meet the walls of the device without splashing and flow into the receiver, at which point the whirling motion of the water is checked by baffles, thus permitting drainage to be easily accomplished.

SHIPPING BOARD HAD 9,243,464 TONS CONTROLLED ON JUNE 5

Fleet Lacks Combined Passenger and Cargo Vessels; Deliveries in May Below Those of April; No Keels Laid in Month

Vessels owned and controlled by the Shipping Board as of June 5 numbered 1,493, aggregating 9,243,464 tons deadweight, including 956 contract steel vessels of 6,429,059 tons, 205 requisitioned steel vessels of 1,334,609 tons, 271 wood and composite vessels of 997,854 tons, four concrete vessels of 13,500 tons, 24 purchased vessels of 157,921 tons, 31 seized German and Austrian vessels of 291,821 tons and two vessels of 18,700 tons chartered from Peru. Cargo tonnage predominates, 1,388 vessels of 8,273,246 tons falling under this heading, while the fleet includes also 59 tankers of 549,280 tons, 15 refrigerator ships of 112,620 tons and three transports of 26,621 tons.

Deliveries of new ships to the Shipping Board by American shipyards during May fell far below the high mark established in April. They numbered only forty-six vessels, aggregating 256,410 tons deadweight, representing a reduction of approximately 50 per cent as compared with April, when eighty-nine ships aggregating 522,683 tons deadweight were turned over to the Government.

The slowing up in activity revealed by the official figures is believed to be due in a measure to labor troubles at the shipbuilding plants and also to the fact that as the program of the Emergency Fleet Corporation draws nearer to a close the shipbuilding facilities are less concentrated on work for the Government.

No keels were laid during May, but twelve vessels were launched, all of them steel, aggregating 97,600 tons. The number of keels remaining to be laid is twenty-two, all contract steel ships. May deliveries included thirty-three contract steel vessels of 228,110 tons deadweight, two requisitioned steel vessels of 13,000 tons, five wooden ships, tonnage not stated, and two concrete vessels totaling 15,000 tons. An official statement compiled as of June 5 shows that one contract steel vessel of 5,075 tons and two wooden ships were delivered this month up to that date. One launching took place during this period, a 10,000-ton steel vessel slipping down the ways.

The lack of combined cargo and passenger vessels to balance the fleet is demonstrated by the fact that only twenty-eight of this type, aggregating 281,697 tons, are included in the compilation, all obtained by seizure from Austria and Germany except two chartered from Peru.

Following is a comprehensive view of the Government program:

	Keels Laid		Launched		Delivered	
	No.	D. W. T.	No.	D. W. T.	No.	D. W. T.
Month to Date—						
Contract steel	1	10,200	1	10,000	1	5,075
Year to Date—						
Contract steel	25	228,150	158	1,204,718	220	1,486,139
Requisitioned steel	6	61,400	7	61,770	10	82,870
Wood	..	......	16	31,050	43	84,650
Concrete	..	......	....	......	3	18,500
Total	31	289,550	181	1,297,538	276	1,672,159
Total to Date—						
*1,300 Contract steel	1,278	8,597,245	1,172	7,649,245	1,073	6,842,187
* 384 Requisitioned steel	384	2,687,266	374	2,585,966	372	2,572,666
* 18 Composite	18	63,000	18	63,000	18	63,000
* 589 Wood	589	1,885,250	589	1,885,250	570	1,881,250
* 12 Concrete	12	73,500	7	36,000	6	28,500
Grand total, *2,303	2,281	13,306,261	2,160	12,219,461	2,039	11,387,603

* Number of ships on active programme.

ALIENS MAY LEASE SHIPS

Temporary Measure Provides For Three Months Time Limit

The United States Shipping Board has passed a resolution providing that vessels documented under the laws of the United States may be chartered for periods not exceeding three months, or for a voyage the probable duration of which will not exceed three months, to persons not citizens of the United States.

This order is issued to temporarily care for the situation brought about by the passage of section 18 of the Merchant Marine Act of 1920, which amends section 9 of the Shipping Act of 1916, in such manner as to require the forfeiture of the vessel in the event of a charter to aliens other than under regulations prescribed by the board. At a later period specific regulations will be issued by the board covering the subject of voyage and time charters.

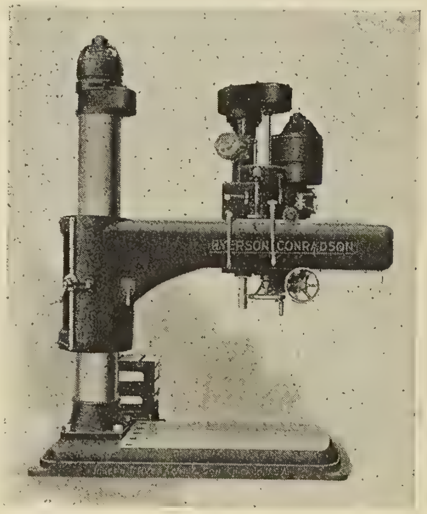
Bids Wanted for Ocean Mail Service

The Post Office Department will receive bids until September 15, 1920, for ocean mail service in vessels of the first-class, service to begin October 12, 1920. This work is under the provisions of the mail subsidy act of 1891. Circulars containing descriptions of the routes, instructions to bidders, and blank forms of proposals with bonds may be obtained from the Second Assistant Postmaster General after July 1.

High Power Radial Drilling Machine

Among the new machine tools being placed on the market by Joseph T. Ryerson & Son, Chicago, Ill., is the Ryerson-Conradson Twin Motor-Driven High Power Plain Radial Drilling Machine.

This machine differs somewhat from the usual design, and drilling, tapping, boring and reaming operations can be performed equally well. The machine has but four shafts and sixteen gears. The



High Power Radial Drilling Machine

spindle and driving shafts are contained in a single cast box of rigid construction. Only spur gears are employed, eliminating bevel gears and the consequent trouble of alinement.

The special features of the machine include a twin-motor drive, one motor being used for driving the spindle and the other for elevating purposes, mounted on the column. All bevel gears and friction clutches for tapping have been eliminated. Because of the box section design of the arm, the usual overhanging head is done away with. In the spindle drive arrangement there are only three gear transformations, which eliminates the numerous bevel gears usually found necessary. In getting rid of these gears, the trouble of alinement has also been avoided. Because of the construction, the tool may be operated on a true radial line with the column. The long bearing surface and double-acting clamping device of the arm on the column reduces all springing and sagging action to a minimum.

Support for Waterways Bill

At the third annual convention of the Mississippi Valley Waterways Association, in St. Louis, April 19, resolutions were adopted strongly urging the passage of the Newton Bill, providing means for completing the plans adopted for the improvement of the Mississippi, Ohio, Illinois and Missouri Rivers, urging the appointment of a man familiar with the subject as a member of the Interstate Commerce Commission, and the building of twenty-four barges suitable for grain, flour and merchandise.

STATE BARGE CANAL TO HAVE GREATLY INCREASED SERVICE

New Companies to Handle Bulk Cargo in Both Directions Direct Between New York and Western Ports

The following circular for the information of shippers of freight through the New York State Barge Canal, giving details as to the plans of new companies engaged in handling that traffic, has been issued by Edward S. Walsh, State Superintendent of Public Works:

"The Inland Marine Corporations, S. W. Bullock, traffic manager, 132 Nassau Street, New York City. This company will operate a line of steamers and barges between Buffalo and New York City accepting east and west-bound bulk cargo for practically all ports between Albany and Buffalo, inclusive. Carload and less carload freight will be accepted from New York for Buffalo and points west via canal and lake.

The Lake Champlain Transportation Company, C. E. Holden, general manager, Whitehall, N. Y. This company will operate a number of barges in a bulk cargo service on the Champlain and Erie divisions of the canal system, accepting freight for all ports between Buffalo and Albany, and to and from points in Canada, reached through Lake Champlain and connecting waters to the St. Lawrence River.

"The New York and Western Canal Line, H. J. Ware, general manager, New York City. This company will operate a number of barges in a general cargo service from New York City to all canal ports west of Albany. Bulk cargo will be handled from all ports west of Albany in eastbound movement.

"E. G. Murray Lighterage & Transportation Company, E. G. Murray, general manager, New York City. This company will furnish barges for bulk cargo, loading from New York to any canal port.

"Marine Express Company, R. H. Barnwell, general manager, New York City. This company will operate a number of barges providing a weekly service between New York City and ports on the Oswego division of the canal system, including the port of Oswego.

"In addition to the foregoing, there are available for service a number of individually owned and operated barges. Arrangements may be made for the charter of such boats direct with the owners or operators, or inquiry may be directed to Traffic Bureau, Department of Public Works, Albany, N. Y., and shippers will be placed in touch with boat owners. On eastbound traffic the Seaboard Forwarding Company, 72 Pearl Street, Buffalo, N. Y., and the Marine Forwarding Company, Chamber of Commerce Building, Buffalo, N. Y., will furnish equipment and quote rates.

"The Department of Public Works will operate a fleet of towing tugs on the Erie, Oswego and Cayuga-Seneca divisions of the canal system. Boats will be towed by department tugs at the following rates:

LOADED	Cents Per Mile
300 ton or less	35
300-350 ton	42
350-400 ton	49
400-450 ton	56
450-500 ton	63
500-550 ton	70
550-600 ton	77

LIGHT	Cents Per Mile
Up to 100 feet long	20
100-110 feet long	25
110-120 feet long	30
120-130 feet long	35
130-140 feet long	40
140-150 feet long	45

"Barges or other craft of greater burden or dimensions will be towed at a rate to be fixed on application to the department."

Yachtsmen Have Organization

An organization to be known as "The Yacht Brokers' Association" has been formed for the following purposes: To generally encourage a greater interest in the sport of yachting; to render more efficient service to yachtsmen and cooperate more closely with those interested in the sport; to protect and further the interests of those legitimately engaged in the yacht brokerage business; to adopt a common system for registering competent and reliable officers and crews for the benefit of yacht owners in general.

The constant activity of yacht brokerage firms unquestionably develops material advantages to the yachting fraternity, in that it tends to create a market for owners who desire to dispose of or charter their vessels and to establish reasonable and to some extent a standard value for their property.

Marine Control Apparatus

The Cutler-Hammer Manufacturing Company, of Milwaukee and New York, describes and illustrates their electrical control equipment for use on board ship in a two-color booklet with the above title.

The extensive use of electric control in the marine field is emphasized by the statement that on a battleship, for instance, "there are approximately 225 motor and controller equipments used with the auxiliaries, of which there are 45 different control applications, and the sizes range from 1 horsepower to 175 horsepower." The booklet illustrates and describes the controller panels and double master controller with two drum levers for controlling a boat crane. One drum lever controls the hoist motion and the other the rotating motion. A solenoid-operated valve for use with submarine torpedo tubes is an interesting piece of apparatus. The officer at the periscope, when he has sighted his prey, closes a switch which operates the valve, admitting compressed air to the torpedo tube and sending the torpedo on its errand. Many other controls for capital and merchant ships and submarines are illustrated. According to the booklet, Cutler-Hammer control apparatus has been supplied to the United States Navy for the past twenty years.

OBITUARY

Whitfield P. Pressinger

Whitfield P. Pressinger, of New York, vice-president, Chicago Pneumatic Tool Company, died June 10 as a result of complications following an operation. Mr. Pressinger was actively engaged in the pneumatic tool and allied machinery industry for many years. He was general manager of the Clayton Air Compressor Company for seven years, and

Whitfield P. Pressinger

became widely known through numerous activities in the American Society of Mechanical Engineers and the Compressed Air Society. He was born in New York City in 1871.

In addition to the foregoing societies he was a member of the Sons of the Revolution, 7th N. Y. Regiment Veterans, F. and A. M., and the Engineers, Lawyers, New York Athletic, New York Railroad, Columbia Yacht and the Machinery Clubs of New York.

Baizley to Build Big Dock

The proposed $6,000,000 drydock plant at Gloucester City, N. J., is to be built by the John Baizley Iron Works, according to an ordinance passed by the City Council, which provides for the closing of three streets on the water front, that the work must be started promptly, and the plant put in operation as soon as it is finished.

NEW U. S. MAIL LINE LEASES THIRTEEN EX-GERMAN STEAMERS

Subsidiary of the France and Canada Steamship Corporation Gets Some Fine Ships for European Passenger and Freight Traffic

Thirteen former German passenger steamers, including the George Washington, President Grant and America, have been chartered from the Shipping Board by the United States Mail Steamship Company, a subsidiary of the France and Canada Steamship Corporation, 120 Broadway, New York. The total tonnage involved is about 90,000 tons, and the Shipping Board states that the stock ownership and management of both concerns is 100 percent American, the France and Canada Corporation being the unconditional guarantor of the United States Mail Steamship Company under the terms of the charter, which is for five years, and will mean an income to the Shipping Board of about $20,000,000.

The vessels chartered are the George Washington, Pocahontas, Mount Vernon, Callao, Susquehanna, President Grant, America, Princess Matioka, Agamemnon, Antigone, Amphion, Freedom and Madawaska.

These vessels are to ply routes from New York and Boston to British, French and German ports and to Danzig. The chartering company is also to have the right to run service to Mediterranean ports. At the expiration of the five-year period of charter the company is to have the first chance to purchase the vessels at prices and under terms to be then fixed by the Shipping Board.

Two more vessels, the Aeolus and the Huron, are to be chartered under the same conditions if the Shipping Board can obtain their release from present obligations.

The essential terms of the contract between the Shipping Board and the United States Mail Steamship Company are given by the Shipping Board as follows:

"The United States Mail Steamship Company is to recondition these vessels for passenger service at its own expense. The plans for reconditioning are to be subject to the approval of the Shipping Board. The steamship company is to pay the government a bare boat charter hire at the rate of $3.50 per net registered ton per month. Off hire, for overhauling and repairing is permitted, but not to exceed thirty days in any one year.

"The charter is to run for a period of five years. At the termination thereof the steamship company has the first chance to purchase the vessels at prices and terms then to be fixed by the board. In case of purchase the steamship company is to be credited on the purchase price with the amount of money spent in reconditioning vessels for service, minus depreciation, at the rate of 7½ percent per annum. If the steamship company does not purchase, the amount so spent in reconditioning, minus depreciation, is to be returned in cash.

"Under the charter, all of the expenses of operation of these vessels, including insurance, are to be borne by the steamship company, and the return to the government is net.

"The contract also provides that, in the event that the steamship company enters into any contract with the North German Lloyd Steamship Company or the Hamburg-American Lines for the use of the piers,, warehouses, facilities, etc., of either of said companies, such agreement shall be subject to the approval of the Shipping Board.

"The steamship company also agrees to take the Aeolus and the Huron under the same conditions, provided the Shipping Board can secure their release from their present commitments to the South American service by the substitution of other suitable vessels.

"The routes for which the vessels are chartered are as follows:

"New York - Queenstown - Cherbourg-Bremen. Returning via Cherbourg - Southampton. Alternative route. New York-Dover-Boulogne-Danzig.

"Boston - Queenstown-Cherbourg-Bremen. Returning via Southampton-Cherbourg."

The George Washington, formerly of the North German Lloyd, carried President Wilson four times across the Atlantic in connection with the Paris Peace Conference: and the Mount Vernon was attacked and badly damaged by a German submarine.

British Shipyards Combine

A combination of small but efficient British shipyards is announced. The Rennie Forrest Shipbuilding, Engineering & Dry Dock Company, of Wyvenhoe, Essex, has joined with William Chalmers & Company, of Rutherglen, and Ritchie, Graham & Milne, of Glasgow, to form the Rennie, Ritchie & Newport Shipbuilding Company, Ltd., with a capital of £500,000. The net assets taken over are valued at £330,000. Works are to be established at Newport, Monmouthshire. The new company will have one yard on the east coast of England, one on the west coast, and two on the Clyde.

MORRIS M. WHITAKER

Joins Tams, LeMoine & Crane Naval Architects

Morris M. Whitaker, naval architect, has joined forces with Tams, LeMoine & Crane, of 52 Pine Street, New York, and will have active charge of the designing and supervision of the construction in the commercial and cargo ship department, as well as their yacht work.

Mr. Whitaker comes from a family which has followed the sea for generations, his father having been a chief engineer in the United States Navy, serving through the Civil War and up to 1895. He was graduated from Yale, and started his professional career with the Newport News Shipbuilding and Dry Dock Company. From there he went to Cornell University to take a post-graduate course

Morris M. Whitaker

in naval architecture, following which he returned to the Newport News yard, and later took charge of the construction of C. R. Flint's famous steam yacht *Arrow*.

During the war he was engaged on special engineering work for the Russian Navy, and later designed and laid out a yard for building submarine chasers. During the latter part of 1917 he was engaged by the Emergency Fleet Corporation to design and standardize life-saving equipment.

Tams, LeMoine & Crane have been in business since 1895, and prior to that the same business was carried on under the name of Tams & LeMoine, which partnership commenced in 1888. They have built several well-known yachts, and at present are doing considerable work for South American and Australasian clients, including a tug for British Guiana, a small, shallow-draft Diesel-driven cargo vessel and several barges for South American use.

PERSONAL AND BUSINESS NOTES

G. L. Buchanan has been appointed Cuban representative of the American Bureau of Shipping, with headquarters in Havana, Cuba.

The Pennsylvania Pump & Compressor Company, of Easton, Pa., announces the opening of sales offices in the following cities: New York, 50 Church Street, H. C. Browne, manager; Philadelphia, Pa., 2222 Chestnut Street, W. J. Devlin, manager; Pittsburgh, Pa., 631 Fulton Building, C. W. Gellinger, manager; Richmond, Va., Mutual Building, W. F. Delaney, manager; Birmingham, Ala., 2027 Jefferson Bank Building, H. I. Kahn, manager; Salt Lake City, Utah, Newhouse Building, C. H. Jones, manager; Milwaukee, Wis., 604 First National Bank Building, Coates & Zarling, representatives.

The Page Steel & Wire Company announce the change of their central district sales office from 29 South LaSalle Street to 208 South LaSalle Street, Chicago, Ill. All communications should be sent to our new address.

The Milwaukee Electric Crane & Manufacturing Company, Milwaukee, Wis., announces the appointment of Mr. R. K. Morse as western manager, with offices in the Pittock Block, Portland, Oregon.

The business of the estate of John Nazel has been succeeded by the Nazel Engineering & Machine Works, a corporation chartered in Pennsylvania, with the following officers: Ralph W. Nazel, president and general manager; C. H. Wackernagel, vice-president and assistant manager; J. Milton Nazel, secretary and treasurer.

The trustees of the pension fund of Fairbanks, Morse & Company, 900 South Wabash Avenue, Chicago, Ill., report for 1919 eight members pensioned, death benefits of $11,675, and net resources of $505,000, practically all invested in high-grade bonds. The fund was established on January 1, 1917, and at the close of 1919 had 1,139 contributing members.

Engineering clubs and societies, manufacturers' associations, commercial organizations, technical schools and the educational departments of large corporations will be interested in the announcement that the Diamond Power Specialty Company, Detroit, Mich., now has available for free distribution three copies of its motion picture, "Coal Is King." This picture was prepared from a scenario by Robert June, and the pictures were taken under his direction by the Ford Motor Company.

Craig Adair, formerly vice-president of Penn Seaboard Steel Corporation, and Mr. Paul Day, of the same corporation, have resigned and have formed the Adair-Day Corporation. They will make a speciaty of anchors and chain, gray iron, steel and brass castings, for marine work, general steel products and mechanical specialties, with offices at 1025 Widener Building, Philadelphia, Pa.

Walter Kidde & Company, Inc., of 90 West Street, New York City, announce the appointment of J. G. White & Co., Ltd., of London, and L. A. Blake, Inc., of Buenos Aires, as representatives in England and Argentina, respectively, for the sale and installation of the Rich System for Detecting and Extinguishing Marine Fires. The two companies will also establish service stations similar to those now maintained by Walter Kidde & Company in the United States.

The Greenfield Tap and Die Corporation, Greenfield, Mass., has acquired 100 percent of the common stock of the Lincoln Twist Drill Company, of Taunton, Mass, manufacturing twist drills, reamers and milling cutters. These, added to the products of the Greenfield Tap and Die Corporation, gives them a complete line of small tools. The Taunton plant will be enlarged as necessity requires to meet the demands for its products. Mr. Edward Blake, Jr., formerly sales manager of Wells Brothers Company, is vice-president and general manager of the Lincoln Twist Drill Company.

William H. Easton, of the Department of Publicity of the Westinghouse Electric & Manufacturing Company, 165 Broadway, New York, has been placed in charge of the publicity work of that company's marine department.

Mr. Carl Wigtel, vice-president and chief engineer of the Watson-Stillman Company, sailed on June 14 for a ten weeks' trip to Scandinavian countries. He also expects to visit England, France, Belgium and Holland. While he is going mainly for a vacation, this being his first trip to his old home in Norway since his connection with the Watson-Stillman Company thirty-three years ago, he will also investigate new developments in the line of hydraulic machinery in all of the countries named.

At the meeting of the Engineering Advertisers' Association at the Hotel LaSalle, Chicago, on June 8, Mr. Louis Flader, of the American Photo Engraving Association, gave an interesting talk on photo engraving. Mr. Flader's business career has been devoted almost exclusively to the engraving field and he knows his subject thoroughly. The Engineering Advertisers' Association will rest during July and August; the next regular meeting will be held on September 14.

The Penn Seaboard Steel Corporation's new blooming mill at New Castle, Delaware, is now in operation. This mill is a two-high, 34-inch, reversing mill, directy connected to a 6,000-horsepower Westinghouse motor, and equipped with motor-driven screw-down and manipulator.

TRADE PUBLICATIONS

Hack Saws and Their Use is the title of a booklet issued by the L. S. Starrett Company, Athol, Mass., describing the saws, their use, and also contains many suggestions and tables.

Marine Equipment.—Catalogue No. 19, issued by the Stevens, Aylesworth Company, Inc., illustrates with detail drawings some of the many types of marine accessories that this company has produced.

Whiting Cranes.—The Whiting Foundry & Equipment Company, Harvey, Ill., in its 1920 bulletin No. 151, extensively describe and illustrates cranes and various other foundry and railway equipment manufactured by the concern.

Propeller Wheels and Marine Steam Engines.—The H. G. Trout Company, Buffalo, N. Y., in a catalogue just issued describes and profusely illustrates the propellers and engines built by them and the various shops in which they are manufactured.

Standard Anti-Noise Marine Telephones.—This bulletin, published by the Magnavox Company, 2701 East 14th Street, Oakland, Calif., describes and extensively illustrates the Magnavox anti-noise marine telephone, ttype MD-2, its installation and operation.

Steam-Reducing Valve.—The Chaplin-Fulton Manufacturing Company, 28-34 Penn Avenue, Pittsburgh, Pa., in a four-page pamphlet recently issued, describes and illustrates the Fulton steam-reducing valve, as well as price lists of the various types.

Standard Underground Tubes, Rods and Wires.—The Standard Underground Cable Company's bulletin No. 100-1 contains many useful dimensions and tables as applied to the tubes, various kinds of metal tubes, rods and wire manufactured by the company. A complete price list is also given.

Chadburn's Ship Telegraph.— In this catalogue issued by the Chadburn Ship Telegraph Company of America, Troy, N. Y., are described and illustrated the many types of ship telegraphs, engine counters, horoturbometers, etc., manufactured for the merchant service, and the United States Navy.

Portable Alternating Current Apparatus for Cutting and Welding Metals is the title of a catalogue just issued by the Electric Arc Cutting & Welding Company, 222 Halsey Street, Newark, N. J., which describes in detail the company's new welding apparatus, and illustrates its application in actual practice.

The Aerial Railway of Industry is the title of an interesting catalogue recently published by the Shepard Electric Crane & Hoist Company, Montour Falls, N. Y. It describes in detail the Shepard electric cage-operated monorail hoist, which not only loads and unloads, but also conveys the material to any part of the plant or yard.

A Catalogue of Windlasses has just been published by the American Engineering Company, Philadelphia, Pa., which gives full descriptions and illustrations of the various kinds of windlasses manufactured by the company. They call special attention to the fact that they manufacture windlasses to meet the special preferences of shipowners and engineers.

Fire Detecting and Extinguishing System.—Walter Kidde & Company, Inc., 90 West Street, New York, have just issued a revised pamphlet explaining and illustrating with photographs the operation of the improved Standard "C" type of the Rich system for detecting and extinguishing marine fires. Another pamphlet issued by this company contains an address delivered to a recent meeting of insurance men, in which the system is reviewed in more technical detail.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPYARDS

Traveling Crane, Newport News, Va.—The Newport News Shipbuilding Company is in the market for a 100-ton traveling crane.

Schooner Contracts, Hoquiam, Wash.—The Peninsular Shipbuilding Company has contracts in sight for building a number of steam schooners for the lumber trade.

Tankers, Quincy, Mass.—Work will soon start at the Fore River plant of the Bethlehem Shipbuilding Corporation on two vessels for the Sinclair Oil Company, New York.

New Shipyard, Ghent, Belgium.—The Lloyd Royal Belge plans to establish a new shipyard at Ghent under the designation of The Lloyd Royal Belge (Great Britain), Ltd.

To Build Railway Equipment, Jacksonville, Fla.—The Merrill-Stevens Shipbuilding Corporation is said to plan going into the construction of locomotives, cars and other railway equipment.

Shipyard Sold, Stratford, Conn.—The Housatonia Shipyard has been purchased from the Shipping Board by Albert T. Stuart, president of the A. T. Stuart Company, Newton, Mass.

Steel Steamers, Vancouver, B. C.—According to word from the Department of Marine and Fishers, Ottawa, two more steel 8,100-ton steel steamers are to be built at the Coughlan Yards.

Barges, Jacksonville, Fla.—The Gibbs Gas Engine Company is building six barges for M. Garcia, two of which have just been completed. They will be towed to Cuba and used in the sugar industry.

New Shipyard, Metropolis, Ill.—Contracts are to be awarded by a shipbuilding concern at Memphis, Tenn., for a marine ways at Metropolis, Ill. The yard will extend for several blocks along the river front.

Lighters, Jacksonville, Fla.—The Jacksonville Shipping Corporation is having six lighters built for use in Cuban harbors in unloading freight. They will be 30 by 80 feet, and will carry 100,000 feet of lumber.

Shipyard to Resume, Manitowoc, Wis.—C. C. West has bought the Manitowoc Shipbuilding Company's plant for $410,000. He intends to reorganize the concern and continue operations. The plant originally cost $1,500,000.

Barge, Orange, Tex.—The National Shipbuilding Company will soon start work on a 125-ton barge on the deck of a 300-foot by 40-foot barge, being constructed for the National Oil Transport Company for use in the oil trade.

Steamers to Be Made Barges, Mobile.—Two unfinished steamers on the ways of the Murnan Shipbuilding Company are to be turned into barges. They are 5,000-ton vessels, and were originally intended for cargo ships.

Salvaging, London, England.—Offers by salvage companies for the recovery of about 120 unsalvaged wrecks around the coast of the United Kingdom in approximately 12 fathoms of water will receive consideration by the British Admiralty.

Shipyard to Resume, Machias, Maine.—The Job Shipyard is to resume work soon on a four-masted schooner, new arrangements having been completed; frames for two smaller vessels are in the yard, and work on them is to begin promptly.

Increase of Capital, Gulfport, Miss.—The International Shipbuilding Company, with a New York office at 71 Broadway, which is building steel steamers, has been compelled by increased business to increase its capital of $1,000,000 to $5,000,000.

Steel Freighter, Port Jefferson, N. Y.—The New York Harbor Dry Dock Corporation, which recently purchased the Bayles Shipyard, has begun construction of a 5,000-ton steel freighter, a sister ship of the Conimicut, which was launched June 5.

Converting Steamer, Seattle, Wash.—The new Japanese-built steamer Eastern Importer has been delivered to the Shipping Board at Seattle. She will be converted into an oil burner at one of the yards at an expenditure of about $80,000.

Shipyard Plant Buildings, Wareham, Mass.—The Cape Cod Shipbuilding Company will begin active operations on several new buildings at its yard. They will include machine, construction, blacksmith and other shops, with storehouse and office buildings.

Ship Steel Plant, Lauzon, Quebec.—The Davie Shipbuilding Corporation, Levis, Quebec, a subsidiary of the British Empire Steel Corporation, has taken options on property in Lauzon with the intention of building a plant for the manufacture of ship steel.

Motorship, Norway.—The keel for a motorship of 9,000 tons will be laid on the ways of Rosenborg's Werft at Stavanger. The vessel will have two Diesel engines of 1,700 horsepower. It is expected that the ship will be ready for delivery in the summer of 1921.

Six-Masted Schooner, Astoria, Ore.—The Wilson Shipbuilding Company submitted a proposal to the Port of Astoria Commission to alter the Ferris hull, now in the company's yards, into a six-masted schooner and turn her over to the port at a cost of approximately $197,000.

Tankers, Vancouver, Wash.—The G. M. Standifer Construction Corporation have contracts for building three 12,000-ton tankers, the keel for the first having just been laid. The company still has two of the 9,600-ton freighters for the Green Star Line, of New York, to be built.

To Build Big Steamers, Los Angeles, Calif.—The Los Angeles Shipbuilding Company has a contract for five 12,500-ton steamers, on which work has not been started. The Southwestern Shipbuilding Company has seven steamers to complete, including two tankers of 12,500 tons each.

To Build River Steamboats, Vicksburg.—The Vicksburg (Miss.) Ways Company will erect a marine ways on De Soto Bayou across the Yazoo Canal from Vicksburg, and will build river steamboats and barges and do general repairing. All machinery is to be purchased. Address W. T. Campbell, Box 227, Vicksburg, Miss.

Tankers, Seattle, Wash.—The keel for the first 12,000-ton tanker to be built by the Northwest Bridge & Iron Company for the Swiftsure Oil Transport Company was not laid until July 1 on account of steel not being on hand. The company has seven of the vessels, which will be of the single-screw type, to build.

Shipyard Extension, New Orleans, La.—The Doullutt & Williams Shipbuilding Company is planning for the erection of an extension to the machine shop with new equipment, steel fabricating shop and other buildings for ship repair and construction. Two 10,000-ton floating dry docks will also be built. Horace Williams is secretary.

Shipyard Extension, Chester, Pa.—The Sun shipbuilding Company has concluded negotiations with the City Council for closing certain streets in the vicinity of its plant to allow for proposed additions. The company plans to construct new drydocks, additional shipways, with shop and construction buildings.

Bronze Propellers, Seattle, Wash.—The Doran Brass Foundry has a contract for sixty bronze propellers for the United States Shipping Board, Hog Island yard. The order means more than $500,000 worth of work for the Doran plant and sub-contractors who will do the machine work and make the iron castings.

Converting Ship to Oil-Burner, Hong Kong.—The China Navigation Company's steamer Suiyang is being converted into an oil-driven ship by the Taikoo Dockyard & Engineering Company. If this experiment proves a success the company will probably convert several others of the line as soon as they can be taken off the run.

Drydock, Chester, Pa.—The Sun Shipbuilding Company, Chester, Pa., has begun work on the basin for its proposed 10,000-ton floating drydock and hopes to have the dock completed and in operation by March, 1921. The company is building the basin large enough so that if next year's business warrants it another dock of whatever size necessary can be put in.

New Repair Plant, Sacramento, Cal.—The National Engineering & Dry Dock Corporation has been organized by George W. Ley, Max L. Gordon and Abe Raffee, of Los Angeles, and Roy Atkinson, of Santa Monica, with a capital of $500,000. They plan to build and repair ships and do a general engineering business. The location of the plant is yet to be decided on.

Shipyard to Resume, Baltimore, Md.—A. P. Vane, of Vane Brothers, ship chandlers, 602 East Pratt Street, who recently acquired the shipbuilding plant of the Delaware Shipbuilding Company, Seaford, Del., will operate it under the name of the Seaford Marine Railway Company, with plans for extensive activities. Charles R. Marvel is superintendent of construction.

Shipyard Sold, Crisfield, Md.—The Crisfield Shipbuilding Company disposed of its local shipbuilding plant to a new company represented by Egbert L. Quinn for a consideration said to be $50,000. A portion of the plant, including the machine shop, mechanical repair works, etc., recently destroyed by fire with a loss reported at $45,000, will be rebuilt by the new owner.

Refrigerating Steamer, Birkenhead, England.—Cammell, Laird & Company, Ltd., are to build a refrigerated steamer of about 1,300 tons gross for the Union Cold Storage Company, for transporting cold meat. The vessel will be somewhat on the lines of the three Royal Mail Steam Packet Company's twin-screw steamers Dart, Doon and Devon, built in 1912, 1913 and 1914, respectively.

Luggage Steamers, Birkenhead, England.—The Birkenhead Ferries Committee will place, subject to confirmation by the Town Council, a contract with H. & C. Grayson, Ltd., for building two new luggage steamers at a cost of £100,000 each. The steamers will be 150 feet long and 50 feet beam, and will embody in their design the best type of vessel for the Mersey cross-river goods traffic.

To Recondition Steamers, New York.—The United States Mail Steamship Company, backed by the France & Canada Steamship Company, 120 Broadway, will recondition the thirteen ex-German steamers purchased from the Shipping Board; they are the George Washington, Pocahontas, Mount Vernon, Callao, Susquehanna, President Grant, America, Princess Matioka, Antigone, Agamemnon, Amphion, Madawaska and Freedom.

New Dry Dock Company.—The Dry Docks & Ship Repairs Corporation of Philadelphia, John Meigs, president, has been formed to operate a dry dock and ship repair plant on a 35-acre plot near the Reading Railroad ferries in South Camden, N. J. The company is said to have $5,000,000 ready for the work, the site has been leased for five years, and two dry docks, one of 10,000 and one of 6,000 tons, will be erected, also a marine railway.

Machinery and Tools, Weehawken, N. J.—The Lord Construction Company, 105 West 40th Street, New York, has compiled a list of machinery and tools for its new shipyard at Weehawken, N. J., to be operated in the name of the Lord Dry Dock Company. The equipment will include heavy-duty lathes, punches, shears, radial drills, milling machines, boring and drilling machines, grinders, etc. Most of the equipment will be for electric drive.

Contracts for Tenders, City Island, N. Y.—Kyle & Purdy, City Island, N. Y., have contracted with the International Petroleum Company for a 132-foot steel maintenance tender; it will have 450 horsepower fore and aft compound inverted engines, 18 x 38 x 26 inch stroke with one three-furnace Scotch boiler; also for a duplicate of this vessel with the Atlantic Gulf Oil Company. These are to be used as buoy tenders in South American waters.

Cargo Carriers, Wilmington, N. C.—The Carolina Shipyards (George A. Fuller Company) is starting work on four 9,600 deadweight tons steel cargo carriers for builders' account. The keel for the first has just been laid. Launchings scheduled at the yard include the steel steamers Hybert, 4,800 tons, on July 20, and Syros, 4,800 tons, on August 21. Two vessels not yet named will be launched in October and November, and two more in January and February, 1921, each of 4,800 tons net.

Steamships, Troon, Scotland.—Contracts for the construction of two steamships have been placed with the Ailsa Shipbuilding Company, Ltd., Troon, by the Sociedad Anonima Importadora y Exportadora, of Buenos Ayres and Punta Arenas, and Braun & Blanchard, of Punta Arenas. The new ship of the former concern will be of 4,300 tons, to cost $1,352,887, and to be delivered in December. The latter steamship will be of 3,500 tons deadweight, to cost $1,056,031, and be delivered in May, 1921.

Shipyard Extension, Perth Amboy, N. J.—The Perth Amboy Dry Dock Company, Broad Street, will build a two-story steel and concrete addition to its machine shop, 70 x 100 feet, and install new equipment. It is completing an addition to its forge shop, and has arranged for immediate operations in a new boiler, plate and angle shop; delivery of a new dry dock being built at Kingston, N. Y., is expected soon; equipment required will include electrically operated pumping units, valves and other mechanical apparatus.

Shipbuilding Plants for Sale, Detroit, Mich.—Bids on the plants of the Great Lakes Engineering Works at Detroit, Ecorse and Ashtabula, Ohio, are being solicited by the board of directors of the company. The company, which has built some of the largest and most modern freight vessels on the Great Lakes, was incorporated in Michigan in 1902 and opened its plant at Ashtabula in 1910. Since the outbreak of the war they have constructed mainly ocean-going steamships for the government. There is $2,500,000 stock outstanding.

Steel Schooner Wanted.—A Brazilian firm is in the market for a two-masted schooner of approximately 200 tons, length of keel 98 feet 4¼ inches; beam, 22 feet 9 7/10 inches; draft, 6 feet 5½ inches; with latest model crude oil motor of approximately 100 horsepower, all rigging complete; steel hull to be of best quality. Quotations and terms should cover vessel complete, delivered at Rio Grande, Brazil, and approximate time required for construction. Address Foreign Trade Bureau, Department of Commerce, Washington, D. C. Opportunity No. 32,942.

Plant Begins Operations, Fairfield, Md.—The Globe Shipbuilding & Dry Dock Company, with offices at 604 Stewart Building, Baltimore, has begun operations at its plant near Fairfield. The office and mold loft have been completed, and other buildings are being pushed. Three sections of the drydock have been delivered and two are on the way. One thousand feet of pier space and the channel leading from the main channel to the works have been completed, and the excavating of a basin 45 feet for the drydock is in progress. Machinery is being installed. E. W. Grass is special representative.

New Dry Dock, Sparrows Point, Md.—Three of a series of eight pontoons for the new floating dry dock being constructed by the Bethlehem Shipbuilding Corporation have arrived at Sparrows Point from the yard of the Whitehaven Shipbuilding Company, Whitehaven, Md. The new dock will have a lifting capacity of 10,000 and will be 350 feet long. The remaining five pontoons are being rapidly constructed by the Whitehaven plant, and it is expected to have the dock ready for service early in the fall. Bethlehem Steel officials have announced that an additional expenditure of $35,000,000 will complete their expansion programme, making a total of $85,000,000, the $50,000,000 expenditure being nearly completed. When the improvements are completed there will be about $15,000,000 invested in the shipyards; several lare ore steamers will be built for carrying Standard Oil products to Chile and return with ore for the Bethlehem Company.

PORT IMPROVEMENTS

Dredging, Canton, Ohio.—The city of Canton has voted to issue $65,000,000 bonds for dredging and improving the East Creek.

New Fireboat, Philadelphia, Pa.—A new fireboat is to be provided for the harbor of Philadelphia to cost $300,000 to $350,000.

Improving Harbor, Kingston, Jamaica.—Improvements planned in the harbor of Kingston to accommodate large steamers will cost about $1,225,000.

Widening River, Buffalo, N. Y.—The city is having plans prepared for widening Niagara River in and adjoining Buffalo harbor. G. H. Norton is city engineer.

Construction of Dry Dock, Esquimalt, B. C.—Construction of the big Dominion Government drydock at Esquimalt will start September 1. Costt, between $5,000,000 and $8,-000,000.

Jetty to Be Built, Newport, Ore.—Construction work on the north jetty of Yaquina Bay will commence soon, according to the Newport Port Commission. Estimated cost, $500,000.

Dredging, Portland, Ore.—Dredging of the harbor before the Inman-Poulsen mill is planned. Material taken from the river bottom will be dumped in the low places on Ross Island.

Wharf and Shed, San Francisco, Cal.—The State Harbor Commission, Ferry Building, let contract for building a creosoted pile wharf and shed, concrete flooring to the Healy-Tibbitts Construction Company, 9 Main Street; $44,199.

Harbor Development, Hamilton, Ont.—The Hamilton Harbor Board has submitted plans for the development of the bay front involving an expenditure of approximately $20,-000,000; the International Waterways Commission is considering the project.

River Improvement, Houston, Texas.—Plans for improving the lower Trinity River and Turtle Bayou, Houston, have been approved by United States Engineers, Galveston; this will open up much trade territory to Houston by light-draft steamers.

To Build Pier, Venice, Cal.—A company has been organized by C. Daly and others to build a double-deck timber and concrete pleasure pier 150 x 900 feet at Venice. About $350,000. Leads & Barnard, Central Building, Los Angeles, Cal., are the engineers.

Channel Excavation, Albany, N. Y.—E. S. Walsh, Superintendent of Public Works, Albany, N. Y., received only one bid for the excavation of canal channel in the Genesee River, Rochester, from the Stewart Company, 30 Church Street, New York; about $547,500.

Dredging, Baltimore, Md.—The Bethlehem Steel Company has applied to the United States Engineers, Custom House, Baltimore, for permission to widen one-half mile of 35-foot channel leading to the company's ore pier, from 90 to 250 feet, involving about 1,500,000 cubic yards excavation; about $100,000.

Deepening Channel, Portland, Ore.—Manufacturing and business concerns located adjacent to North Portland harbor have addressed a petition to the Port of Portland Commission asking for a channel 25 feet deep and 300 feet wide, and will very soon be acted upon.

Grain Terminals, Oswego, N. Y.—The New York Superintendent of Public Works is having plans prepared for a barge canal grain terminal at Oswego, N. Y., not to exceed $1,000,000, also for a barge canal grain terminal at New York City, cost not to exceed $2,500,000.

Pier, Warehouse, Etc., Punta Arenas, Chile.—The Department of Public Works of the Chilean Government has approved plans for port improvements to consist of a pier for freight and passenger traffic, an esplanade and a custom house and warehouse, at an estimated cost of 2,412,000 pesos, Chilean paper currency (about $482,000), and an appropriation of 250,000 pesos for the preliminary work has already been made. Plans call for a concrete pier 885 feet long by 55 feet wide, equipped for handling of 120,000 tons of freight annually, and for a distance of 374 feet the water will be sufficiently deep for vessels of 2,000 tons.

Dredging, Charleston, S. C.—The Standard Oil Company, Brigade Street & Southern Railway, let a contract for removing 140,000 cubic yards of sand, mud and clay in the Cooper River at the head of Drum Island, to the Atlantic Gulf & Pacific Company, Park Row Building, New York City; 24 cents per cubic yard.

Dredging, North Portland, Oregon.—The Aladdin Ready-Cut House Building Company and thirty other concerns located on the waterway known as North Portland harbor, have petitioned the Port of Portland Commission to redredge the shoaled channel to a depth great enough to permit ocean-going ships to dock.

Deepening Channel, Etc., Portland, Ore.—J. H. Polhemus, engineer of the Portland Port Commission will engage special help and prepare a survey for deepening the channel in North Portland harbor, removing dikes in Willamette slough, and other improvement work. Frank N. Warren is new chairman of the committee.

Dredging, Portland, Oregon.—Plans for improving the ship channel from Portland to the sea have been made by the Port Commission, and Lieut. Col. J. R. Slattery, government engineer, is in charge of the district. The plan will keep three of the four port dredges and two of the government dredges at work up to the middle of November.

Terminal Site, Mobile, Ala.—Plans to close out the deal for the purchase of the Hunter property on the west side of the river near One-Mile Creek for the erection of coal terminals by the Government are nearing completion. The site is to be furnished to the Government free, the City Commission having already agreed to underwrite $50,000 on the purchase price.

Canal Terminals, New York.—The New York State Legislature has made the following appropriations: $750,000 to build canal terminals and furnish facilities for canal traffic at Buffalo, N. Y.; $750,000 to build canal terminals and furnish facilities for canal traffic at New York City; $500,000 to build canal terminals and furnish facilities for canal traffic at Rochester, N. Y.

Channel Deepening, New York, N. Y.—The Hell Gate channel will be deepened to 45 feet for a distance which includes the underwater route taken by the West Side Subway as it heads for Clark Street, Brooklyn, in the East Ri er. At Hell Gate, off Hallett's Point, otherwise known as Frying-Pan Shoals, the depth will be 35 feet. Between Riker's Island and Barreto Point the new depth will be 40 feet. The contract has been awarded to the New Jersey Ship Building & Dredging Company.

Dredging, Mobile, Ala.—The city of Mobile will dredge deeper channels in front of the city wharves, in order to give the large steamships of the new steamship lines inaugurated there ample deep water loading berths. The port has completed the 30-foot channel to the Gulf project which was adopted by the Rivers and Harbors Committee August 8, 1918, the work on which started September, 1918, thus accommodating vessels of large tonnage. The total cost amounted to $8,500,000.

New Terminal, Seattle, Wash.—Smith Cove Pier B, the new public terminal which was constructed at a cost of $2,000,000, is ready for operation. This terminal has berthing space for eleven ocean-going vessels, being the largest commercial pier in the world. It is 2,543 feet long and 365 feet wide, and has a transit shed 500 feet long and 120 feet wide at the street and where the passenger accommodations will be located. Later an additional 500 feet of shed will be constructed, making the total length 1,000 feet.

Government Work

Dredging, Nome, Alaska.—United States Engineer Office, Seattle, Wash., has plans for dredging at Nome, Alaska, at an estimated cost of $18,000.

Dredging, Michigan City, Mich.—Bids for dredging in Michigan City harbor will be received by United States Engineer Office, 537 South Dearborn Street, Chicago, Ill.

Dolphin Pier, Charleston, S. C.—Specification 4228. The Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to build a dolphin pier 318 feet long; about $6,000.

Power Plant, Wheeling, W. Va.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., is arranging to build a new power plant near lock No. 48, near wheeling.

Dump Scow Wanted, Louisville, Ky.—The United States Engineer Office will receive bids for furnishing and delivering one steel dump scow, up to noon, July 8; further information on application.

Dredging, New York.—United States Engineer Office, Room 710, 39 Whitehall Street, New York City, will receive proposals until July 24 for dredging in Mattituck River, N. Y. Information on application.

Boiler Tubes, Charleston, S. C.—Bids will be opened on July 8 for furnishing and delivering charcoal iron boiler tubes by the Superintendent of Lighthouses, Charleston, S. C. Information on application.

Dredging, Wilmington, Del.—United States Engineer Office will receive bids until 11 A. M., July 15, for dredging waterway between Rehoboth and Delaware Bays and Lewes Canal. Further information on application.

Dredging, Wilmington, Del.—The United States Engineer Office, will receive proposals until July 15 for dredging waterways between Rehoboth Bay and Delaware Bay, Lewes Canal, Delaware. Further information on application.

Dredge for Sale, Galveston, Tex.—United States Engineer Office, Galveston, will receive proposals for the seagoing hopper dredge Sabine until noon, July 14; dredge can be examined at Beaumont, Tex. Blank bids and description can be obtained at United States Engineer Office, Galveston.

Dredge for Sale, Galveston, Tex.—United States Engineer Office, Galveston, will receive proposals for the seagoing hopper dredge Sabine until noon July 14; dredge can be examined at Beaumont, Tex. Blank bids and description can be obtained at United States Engineer Office, Galveston.

SHIPPING DEVELOPMENTS

California-Oriental Service, Los Angeles, Cal.—The Los Angeles & Pacific Navigation Company plans to inaugurate a steamship service between Los Angeles, Honolulu and the Orient. Four vessels will be placed on this run to start with, which will be allocated to the Los Angeles company by the Shipping Board.

Steamship Service, New York.—Norton, Lilly & Company, general agents of the American & African Steamship Line, have announced a new service via Suez Canal to the Red Sea and East Africa, beginning with the steamer Gordon Castle. The ports of call will be Massawah, Mombasa, Kilindini, Zanzibar, Majunga, Beira and Delagoa Bay. It is proposed to have regular sailings.

Atlantic-Pacific Coast Service, Seattle, Wash.—The foreign department of the Pacific Steamship Company has taken over the agency of the North Atlantic & Western Steamship Company, of Boston and Philadelphia. This company will establish a steamer service between Puget Sound and Atlantic ports, the first steamer calling at Wilmington and San Francisco and then going north.

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The Minories, Tower Hill, London.

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COLLEGIO DEGLI INGEGNERI NAVALI E MECCANICI IN ITALIA,
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INTERNATIONAL
Marine Engineering

Volume XXV AUGUST, 1920 Number 8

Fig. 1.—Steamship *Antwerp*

Geared Turbine Passenger Steamer Antwerp

The First of Three New Steamships for the Harwich-Antwerp Service of the Great Eastern Railway of England

BY FREDERICK C. COLEMAN

THE Continental traffic facilities of the Great Eastern Railway Company of England have been materially improved by the introduction on May 31 in the Harwich-Antwerp service of the new geared turbine steamship *Antwerp*, recently built by Messrs. John Brown and Company, Limited, of Clydebank, Scotland, a description and illustrations of which we are privileged to publish in this issue.

War Services of the Great Eastern Railway Fleet

It is well within common knowledge that the Great Eastern Railway Company's fleet of steamships suffered somewhat severely during the war period. Of the mail steamers, the *Copenhagen*, the *Dresden* (renamed *Louvain*) and the *Colchester* were sunk, while the *Brussels* was captured by the enemy, but has just been restored by the Belgian authorities to the British Government. The cargo steamers *Clacton* and *Newmarket* were also sunk. The passenger and mail services between Harwich and the Hook of Holland and Antwerp respectively are now worked by the steamships *Archangel* (previously *St. Petersburg*), *St. Denis* (*Munich*), *St. George*, *Amsterdam*, *Roulers* (*Vienna*), *Frinton* and *Brussels*.

The New Steamship

The *Antwerp* is a twin screw steamship 320 feet in length between perpendiculars, 43 feet in breadth, and 26 feet 6 inches from keel to shelter deck, with midship deck house and boat deck extending for about 160 feet, and continued as a forecastle deck. The *Antwerp* is one of three new turbine steamships ordered by the Great Eastern Railway; the second vessel, the *Bruges*, was launched at Clydebank in March last and is expected to be ready for service in August, while a third sister vessel is on order from Sir W. G. Armstrong, Whitworth and Company, Limited, of Newcastle-upon-Tyne.

Construction Details

Each of these three new steamships will have a speed equivalent to the company's boats now used on the Hook of Holland route, and greater than that of any vessels previously in service between Harwich and Antwerp. The general arrangement and constructional details are illustrated in the drawings on pages 626A and B and 627, while photographs giving typical views of the public rooms and also of the geared turbine machinery are reproduced on pages 626 to 630. It will be seen that the hull has a straight stem and a cruiser stern. The vessel was built to Lloyd's rules and special survey for an A-1 shelter deck class.

Accommodations are arranged for 262 first-class and 102 second-class passengers. The first-class dining saloon is on the shelter deck forward, extending from side to side of the vessel, with sitting accommodations for 72 passengers. The walls are panelled in mahogany and satin-

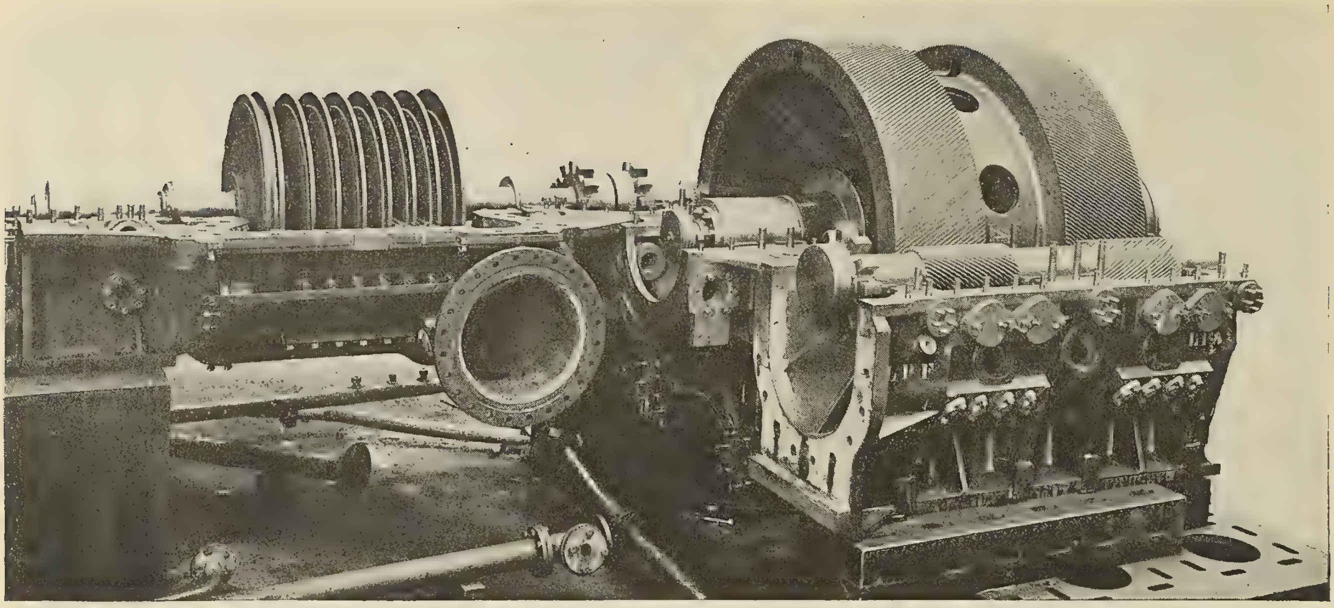


Fig. 2.—High Pressure Turbine and Gearing with Covers Lifted Showing Turbine Rotor, Main Gear Wheel and Low Pressure Pinion

wood. The ceiling is finished in white. An electric "Magicoal" fireplace is arranged at the fore end of the saloon, which has an oak parquetry floor, and there are sofa seats and chairs upholstered in tapestry.

Passenger Accommodations

The first-class smoking room is situated on the shelter deck between the forward and after funnel casings and is panelled in oak, Jacobean style. There is a large, leaded, glass-domed skylight. A large fireplace, with stone jambs, is fitted with armor bright dog grate and club fender seating. The settees and chairs are upholstered in dark blue morocco. Axminster carpet runners are laid over an oak and walnut parquetry floor.

The first-class ladies' room is on the port side of the main deck forward. The walls are painted white with silk tapestry panels. The furniture is of polished mahogany and the settees are upholstered in tapestry. An electric "Magicoal" fireplace is fitted at the forward end.

The first-class lounge is situated in the deckhouse on the boat deck in way of the first-class entrance and stairway. From this space a door leads to a cabine de luxe, which

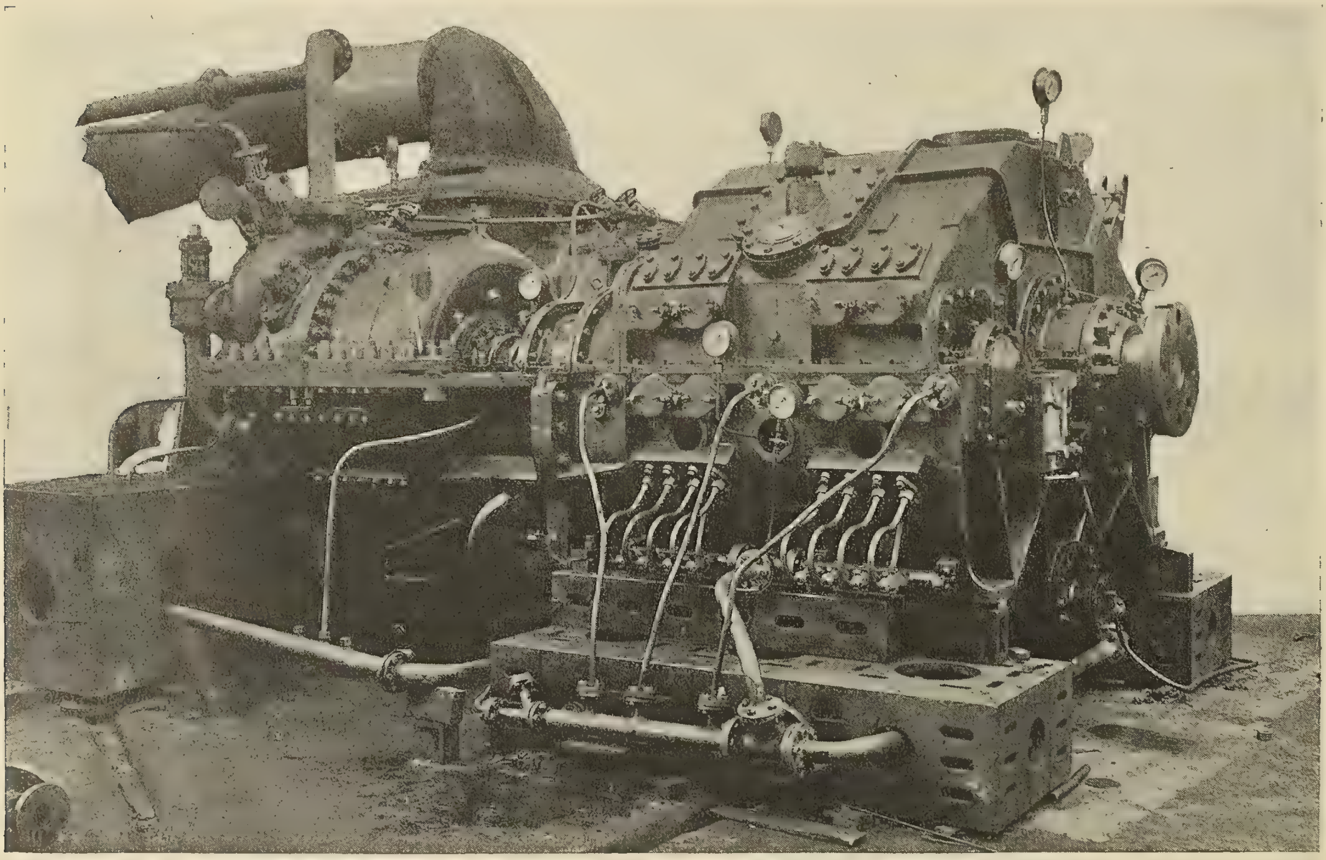


Fig. 3.—Full Set of Main Propelling Machinery Assembled in the Shop at Clydebank

GEARED TURBINE PASSENGER STEAMER ANTWERP

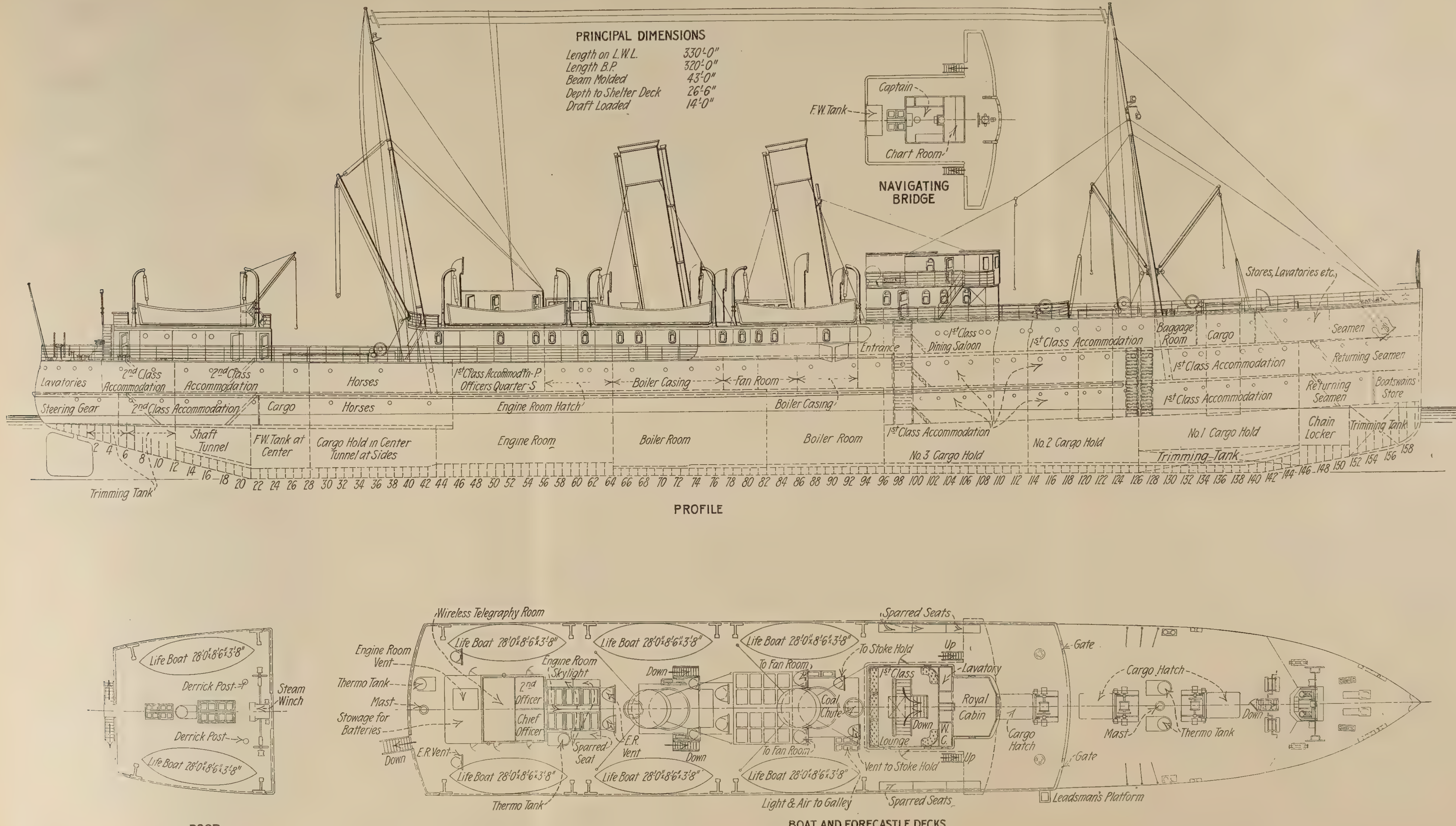
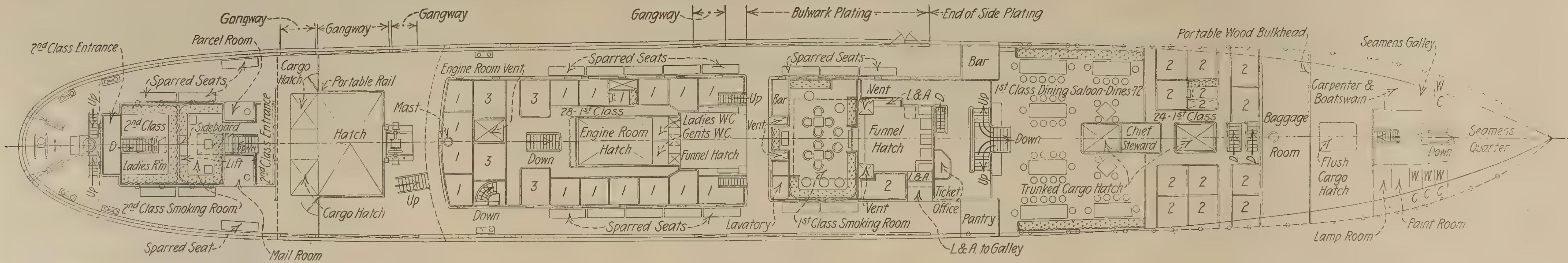
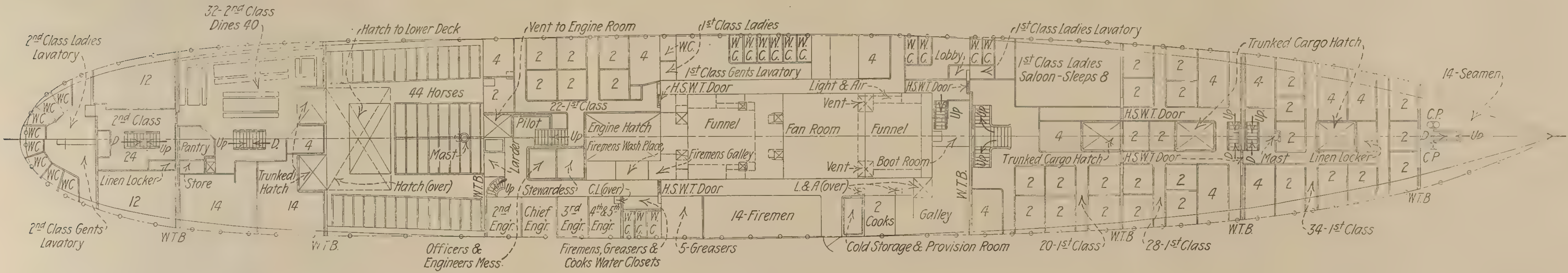


Fig. 4.—Profile and Plans of Boat, Forecastle and Poop Decks

GEARED TURBINE PASSENGER STEAMER ANTWERP





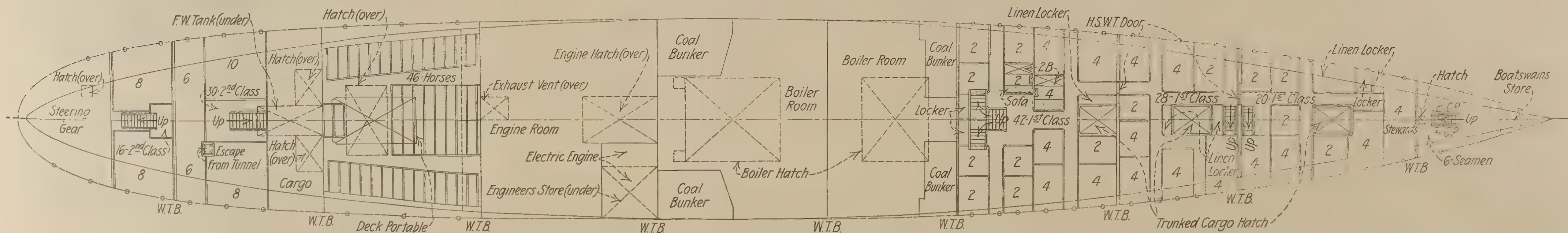


Fig. 5.—Plans of Shelter, Main and Lower Decks

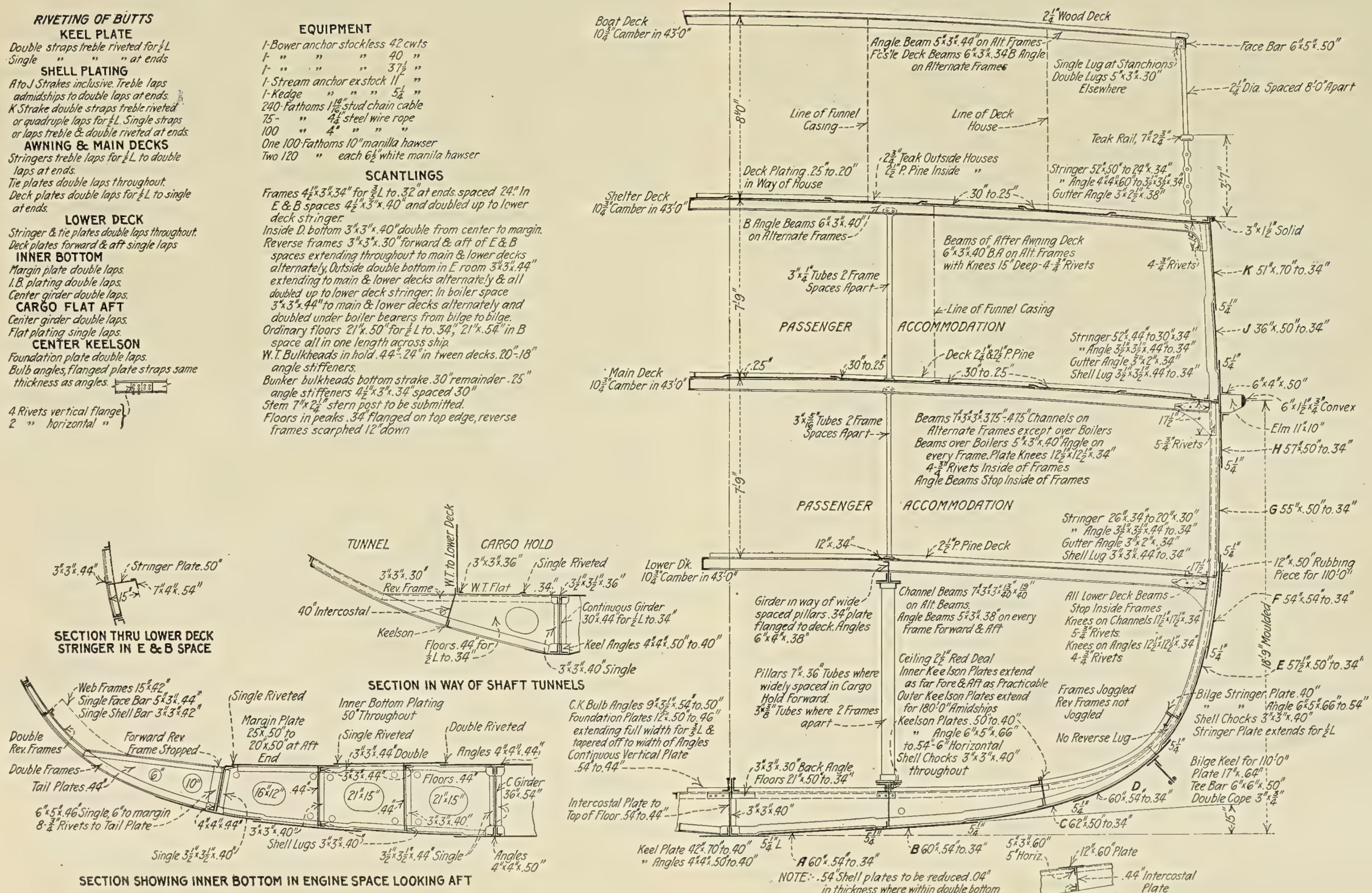


Fig. 6.—Midship Section, S. S. *Antwerp*

Fig. 7.—First-Class Entrance and Lounge on Boat Deck

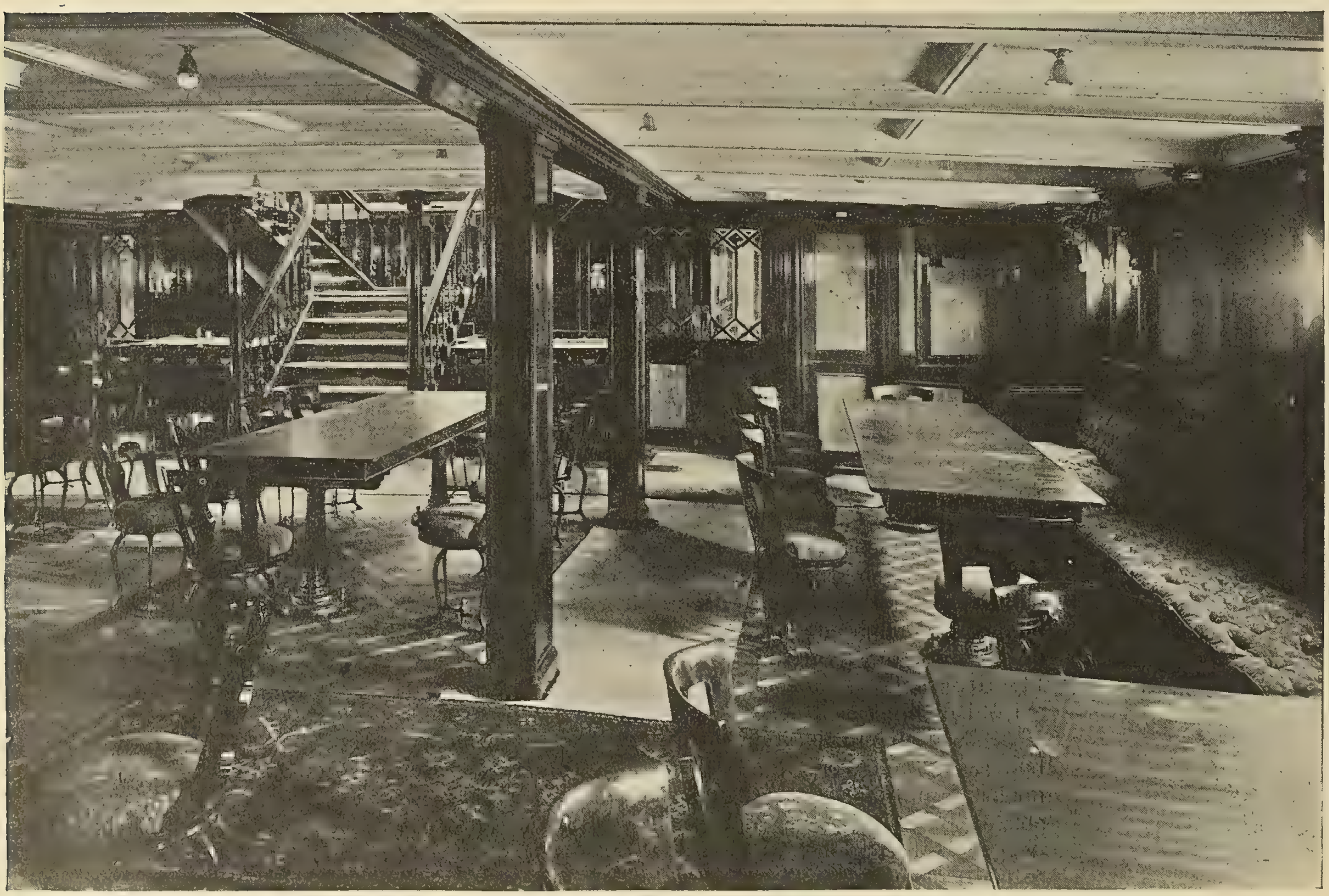


Fig. 8.—First-Class Dining Saloon on Shelter Deck

Fig. 9.—First-Class Smoking Room, Aft End

Fig. 10.—First-Class Ladies Room on Main Deck

has two large polished wood cot beds and handsome writing and dressing tables and wardrobes. The walls and ceiling are white enamel and the floor is covered with blue Wilton carpet.

The first-class staterooms are arranged as one, two, three and four-berth rooms on the shelter, main and lower decks. The walls are neatly panelled and finished in white enamel. The floors are covered with red Brussels carpet and the seats, etc., are upholstered in moquette or cretonne.

The second-class cabins are situated on the main and lower decks aft. The woodwork is finished in white enamel and the floors are laid with Brussels carpet runners. The sofas, chairs, etc., are upholstered in railway repp. The second-class dining saloon, on the port side of the main deck aft, which seats forty passengers, is finished and upholstered in a similar manner to the cabins in its vicinity. The second-class entrances, ladies' room and smoking room are situated in the deckhouse on the shelter deck aft. The floor of the ladies' room is laid with Brussels carpet runners and the sofas, etc., are upholstered in railway repp.

Fig. 11.—Fireplace, First-Class Smoking Room

Officers' and Crew's Quarters

The captain's cabin is on the bridge immediately behind the chart room, the chief and second officers are accommodated in cabins in a house on the boat deck and the engineer officers in cabins on the starboard side of the main deck. The seamen are accommodated on the shelter deck forward and the firemen and greasers on the main deck amidships.

There are eight lifeboats, each 28 feet long, carried on Welin davits on the boat deck, and lifeboats are provided for everyone on board.

Arrangements are made whereby ninety horses can be carried in separate stalls, forty-four on the main deck and forty-six on the lower deck, and the hatchways and gangways are designed to ensure their safe handling and embarkation.

An efficient scheme of ventilation on the thermotank system is installed. By means of five thermotanks the air (which can be heated, if necessary) is conveyed in trunks to the various compartments. In way of the first-class accommodations the thermotanks are arranged in pairs so that either or both thermotanks can be used to supply air to that particular section of accommodation.

All the watertight doors are operated on "Stone's" patent system controlled from the bridge. The steering gear, of the Williams-Janney electro-hydraulic type, is fitted on the lower deck aft, controlled by hand and telemotor on the quarter deck and by telemotor from the bridge. A spare motor is fitted in the event of a breakdown.

There are five hatches with a steam winch and a derrick at each hatch. For heavy loads the derrick at the main hatch is specially designed to be capable of handling loads of ten tons.

The vessel is fitted with the Marconi wireless apparatus, comprising two microphones on the ship's side connected electrically to receivers in the chartroom. There is also a submarine sound signalling set.

A storage battery is fitted for emergency lighting, and this has a discharge capacity of 240 ampere hours, equivalent to the maintenance of two hundred 20-watt metallic lamps for six hours.

The Turbine Machinery

The *Antwerp* is of interest as being the first geared turbine steamship of the Great Eastern Railway Company. The main propelling machinery consists of two sets of Brown-Curtis turbines of the latest type, transmitting the power developed through single reduction gearing to the propeller shafts. Each set consists of high pressure and low pressure turbines for ahead working and a turbine for astern working, the high pressure turbine being connected to one pinion of the gearing and the low pressure turbine for ahead working and the turbine for astern working, incorporated in the same casing, being connected with the other pinion of the gearing. Figs. 2 and 3 show this machinery assembled for steam balancing in the fitting shop at Clydebank, Fig. 3 showing an external view of the machinery and Fig. 2 a view of the high pressure turbine with cover removed and the gearing with cover removed.

A condenser of the uniflux type is fitted for each set of turbines and connected by exhaust pipe to the exhaust port of the low pressure and astern turbine casing. With each condenser a centrifugal circulating pump and an air pump of the dual type are fitted.

There is a complete installation for the forced lubrication of the turbine and gearing bearings, and the teeth of the gear wheels and pinions, comprising oil pumps, water service pumps, oil coolers and filters. Feed pumps are also fitted in the engine room, together with the usual adequate equipment of auxiliary pumps, etc.

The boiler installation consists of five single-ended boilers of the cylindrical return tube type and a small donkey boiler arranged to work under the closed stokehold system with the usual fittings for coal burning.

The vessel successfully carried out her steam trials on the Firth of Clyde, when she attained a speed of 21½ knots between the Cloch and Cumbrae Lights on a run of 6 hours duration at a service draft of 14 feet.

Electric Drive Applied to a Trawler

Description of the First Electrically Operated Trawler in the United States—Generators Driven by Eight Cylinder Diesel Engines

BY fitting out the trawler *Mariner,* a wooden vessel of 500 tons displacement built by Arthur D. Story, of Essex, Mass., with electric machinery both for propulsion and for handling the fishing gear, a new application has been found for electricity in the marine field. Not only is all of the machinery on the vessel operated by electricity, but the electric generators are driven by Diesel engines, so that this vessel becomes the first commercial application of the Diesel electric form of drive which has already been installed to a limited extent in pleasure vessels. The electric equipment for the *Mariner* was supplied by the General Electric Company, Schenectady, N. Y., and the Diesel engines by the New London Ship & Engine Company, Groton, Conn.

Fig. 1.—Electrically Propelled and Operated Trawler *Mariner*

The principal dimensions and characteristics of the vessel are as follows:

Length overall	150 feet 0 inches
Length on load waterline	140 feet 0 inches
Beam	24 feet 3 inches
Mean draft	11 feet 9 inches
Displacement	500 tons
Cruising radius at 10 knots	6,000 miles
Cruising radius at 7.5 knots	9,000 miles

Accommodations

The engineer's quarters are located right aft of the engine room beneath the after deck house. The captain's cabin is on top of the after deck house abaft the wheel house, while the crew are forward in the forecastle below the main deck. The galley is in the after deck house.

Propelling Machinery

The propelling machinery consists of two eight cylinder, four cycle Nelseco Diesel engines, rated at 240 brake horsepower at 350 revolutions per minute. These engines are direct connected to two generators, each generator being rated at 165 kilowatts at 125 volts. For propulsion, these two generators are run in series and supply power to the main motor, which is rated at 400 brake horsepower at 200 revolutions per minute. The rated voltage on the motor is thus 250 volts. If so desired, the main motor can be run at any reduced voltage, and in case the maximum impressed voltage on the motor does not exceed 125 volts, then one of the generator units can be shut down entirely and the motor operated entirely from the other generator unit. Connections are supplied and means of adjustment are provided so that any range of voltage and current can be supplied to the main motor and the load divided up on the main generating units as desired.

The main motor is placed at the forward end of the engine room with the line shafting running down between the generator units. The main generator units are placed with the generators forward adjacent to the main motor and the switchboard is placed on the starboard side of the vessel at the forward end of the engine room so that all electrical leads to and from the motor and generators are as short and direct as possible.

There are several reasons for placing the motor at the forward end of the engine room. In the first place, the lines of the vessel are so fine aft that it would be impossible to locate the motor and generator units to advantage in any other way. Secondly, the thrust bearing is placed adjacent to the main motor and with this arrangement it is only necessary to lift a section of line shafting in order to be able to draw the tail shaft into the boat and remove it. The shipowner will readily appreciate this point. Another reason for locating the electrical machinery at the forward end of the engine room is that it places it higher above the lowest point of the bilge so that any bilge water, etc., will readily drain away from the machinery. This arrangement of machinery gives ample room around every part, and the advantage of this when it comes to the care of the machinery during operation and when overhauling is readily appreciated by all members of the engineering force.

Both the generators and the motors are designed specifically for sea duty, and are provided with non-corrosive fittings and heat resisting insulator throughout. The bearings are so constructed as not to leak oil when the ship pitches. The machines are designed so as to be waterproof and to prevent flashing in a moist atmosphere, or when the engine room is flooded in heavy weather.

Another important point in connection with this installation is that a large motor—that is to say, about 100 horsepower—is required for the winch for handling the

Fig. 2.—Bow View of *Mariner*

trawl. This motor is a 125-volt machine and takes its power from either one of the main generating units. Furthermore, all the other auxiliary power and lighting circuits on the boat are of 125 volts, so that power for either the lights or the auxiliary machinery can be taken from either one of the main generating units even though these main generating units may be supplying power to the propelling motor. Furthermore, there is a small auxiliary generating set, consisting of a 15-horsepower Fairbanks-Morse type *Y* engine driving a 10-kilowatt, 125 volt generator by means of a silent chain. This auxiliary unit will be required only when in port and both of the main generating units are shut down. At sea the two main generating units will be running most of the time, and in any case one will have to be running, and at that time all the power required for both lights and auxiliary power can be taken from either one of the units.

Advantages of Machinery Arrangement

It will be readily seen that this is a very flexible arrangement and not only provides great security against total failure but also requires a minimum amount of machinery to be in operation at any time. It also means that whatever machinery is in operation will be loaded up to good advantage and thus obtain good fuel economy. The auxiliary engine uses the same fuel as the main engines.

There is a small motor driven emergency air compressor which can be used in cases of emergency to fill the air starting bottles. While, with the two engines available for generating power, there is very little likelihood of a total loss of starting air or even a lack of spray air due to the breaking down of the regular compressor equipment, at the same time, if by any chance all starting air is lost, the auxiliary generating unit can be started by hand, which will supply power for the emergency compressor set and thus obtain starting air enough to start one generating unit and then the other. The air compressors on the main generators are of very large capacity, so that even though both compressors on one engine fail, there will still be enough spray air available from the other unit to keep both units going at slightly reduced power.

With all these arrangements it is almost impossible to conceive a situation where all power will be lost and the ship unable to make its own way to port. Of course, there is only one propelling motor and one propeller, but since the motor is of such very heavy duty type there seems to be little likelihood of anything of this kind happening, and certainly the ship is far better off in this regard than even the single screw steam reciprocating engined vessel.

Trial Trip

The official trial of the *Mariner* was held on November 29, 1919. Dock trials had been held previously, but this was the first real test at sea, and the ship lived up to expectations in every way.

The first test was more of an endurance trial, during which the engines were operated at increasing power, finally working up to full power and speed, which was maintained for several hours. The speed of the boat was a little over ten knots and was obtained on about 195 turns of the propeller, which is a three-bladed, cast iron wheel, 94 inches diameter by 68 inches pitch. The ship ran very steadily and the general absence of vibration was very noticeable. In fact, at any part of the ship except in the immediate vicinity of the engine room there was nothing to indicate the presence of any power in the vessel. The fuel consumption at full power amounted to about 30 gallons per hour, and on the basis of the fuel tank capacity of 17,000 gallons gives a radius of action of about 6,000 sea miles.

At the conclusion of the full power test various maneuvering trials were held and the capabilities of the arrangement in this line were amply demonstrated. With one engine shut down entirely and conditions adjusted to load the other engine up to full power, a little over three-quarters speed was attained. The economy of such an arrangement is at once apparent, since the fuel consumption was cut in half and the speed was reduced only about 25 percent, thus giving a radius at this speed of nearly 9,000 nautical miles, which is something of an achievement for a boat only 140 feet long and displacing only one hundred and fifty tons.

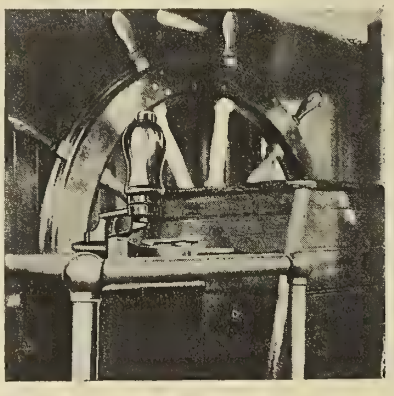


Fig. 3.—Steering Wheel and Speed Controller in the Pilot House

Quick reversing trials were also held. In connection with this, it should be noted that the control of the motor is carried right up to the pilot house and there all movements of the main motor are controlled by a controller which looks very much like the ordinary trolley car controller. There is a small lever which determines ahead, stop or astern rotation and also the regular controller handle which determines the speed. Electrical instruments are fitted adjacent to this controller in the pilot

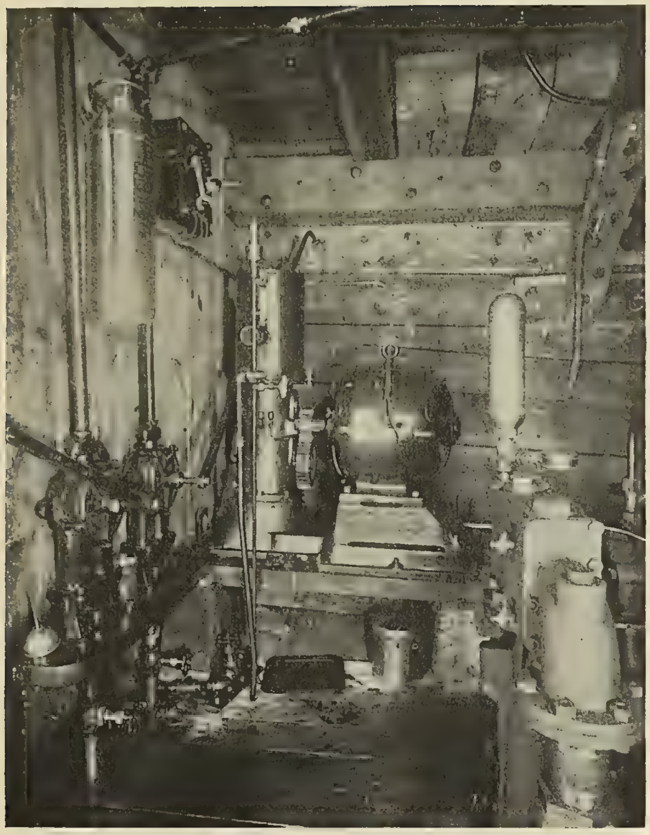


Fig. 4.—Auxiliary Air Compressor

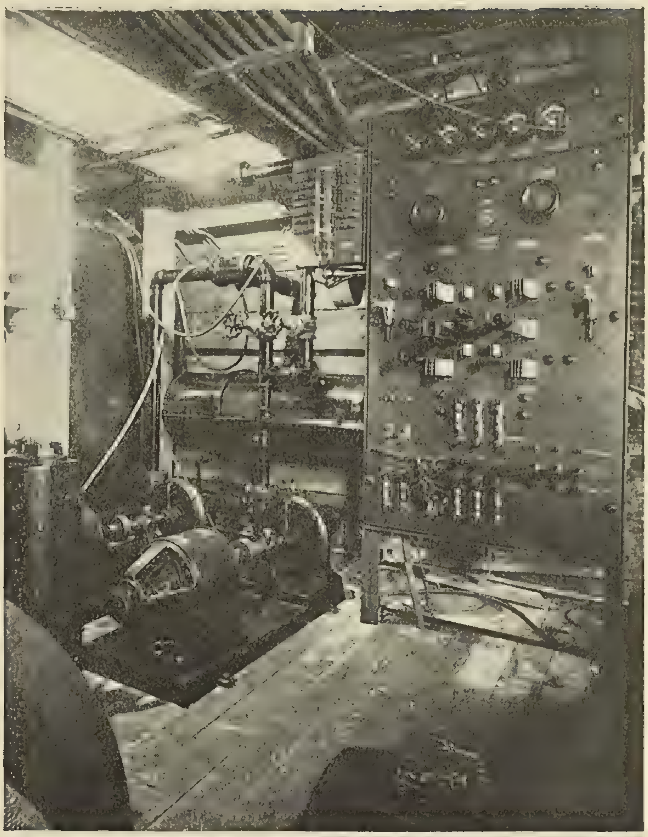


Fig. 5.—Main Switch Board

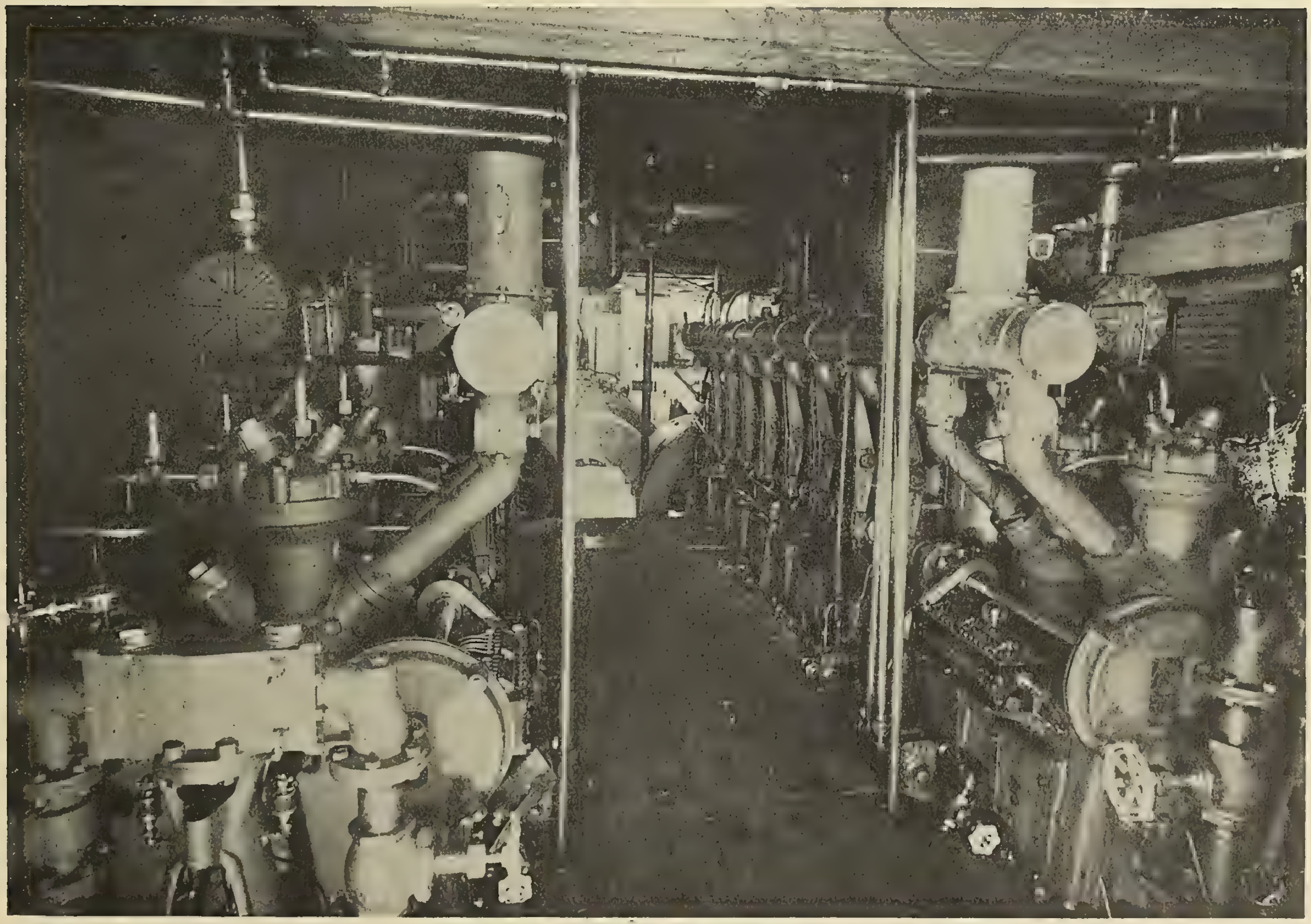


Fig. 6.—Main Engines of 240 Brake Horsepower Each, Looking Forward

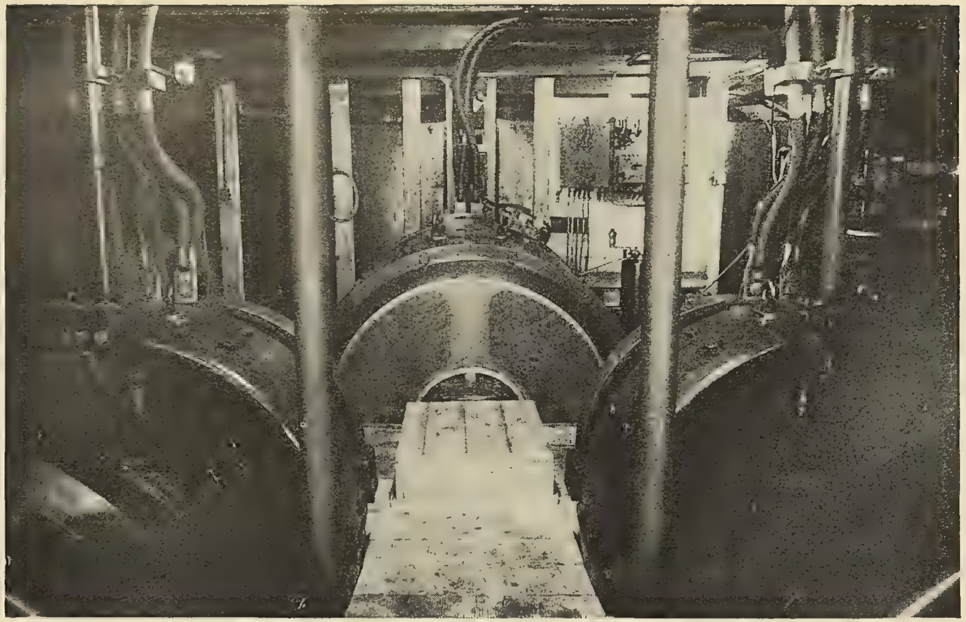


Fig. 7.—Generators and Motor, Looking Forward

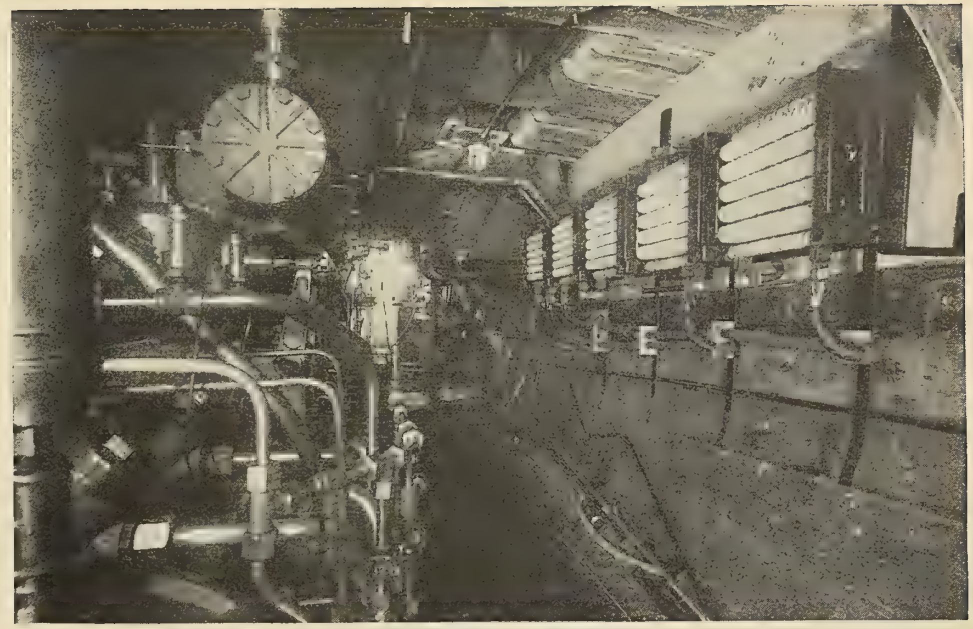


Fig. 8.—Resistance Boxes

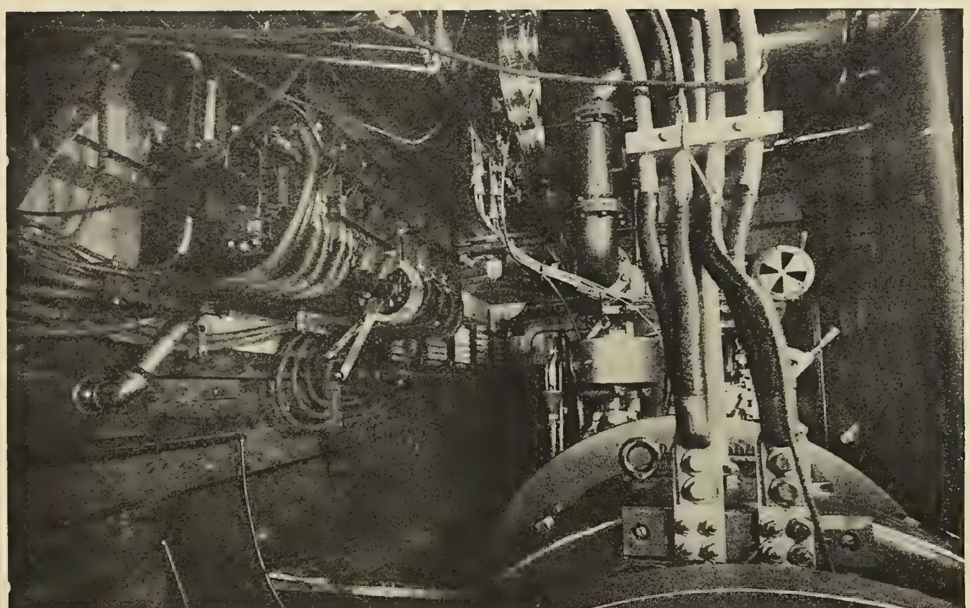


Fig. 9.—Contactor Panel

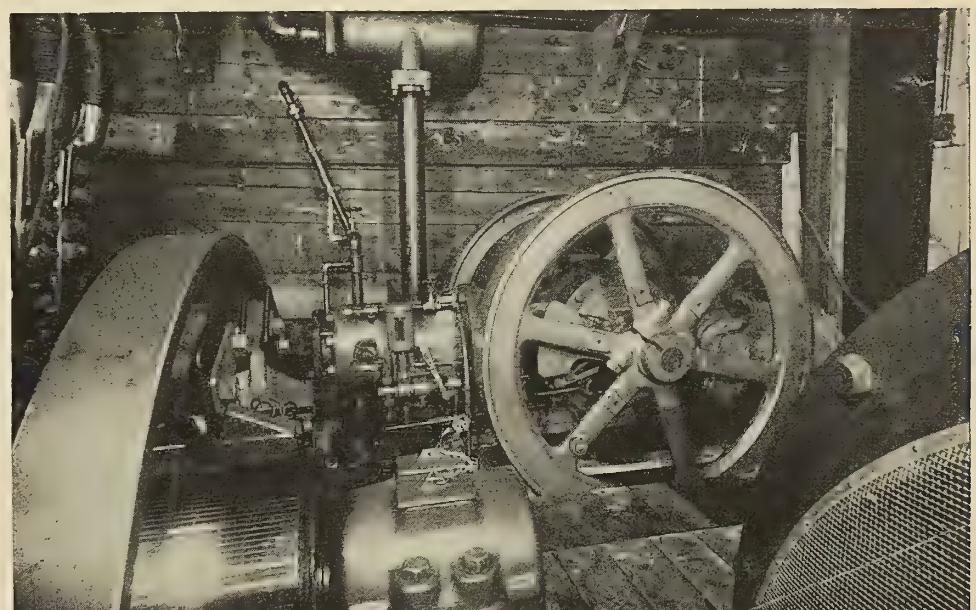


Fig. 10.—Auxiliary Lighting Set

house showing the conditions at all times, so that the captain can see at a glance just what generator units are running, how much load they are carrying and just what the main propelling motor is doing.

Quick Reversal of the Vessel

It was found on the average of several trials that starting with the ship going full speed ahead it took on an average of two seconds from the time when the signal was given to the time when the propeller started in the reverse direction and, furthermore, it took from 15 to 18 seconds, starting with the ship going full speed ahead, from the time when the signal was given to the time when the propeller had been reversed and the main motor was developing full power and speed astern. Of course, during the time that the motor was being worked up to full power and speed astern the ship was losing way, and by this time the ship had lost most of its headway and was fast coming to a standstill.

An important point in connection with this control gear in the pilot house is the automatic re-setting of the circuit breakers in case it is accidentally tripped by supplying power to the motor too fast, by simply bringing the controller back to the stop position. In this way no time is lost and it is not necessary to wait for somebody in the engine room to re-set the circuit breakers. The advantage of this when maneuvering in close quarters is readily appreciated.

It was also interesting to be down in the engine room during these quick reversing trials. The main generating units ran on the governors at all times and the engineers had only to give the engines the usual attention while running. They did not know, unless they happened to look at the switchboard, what load the engines were carrying, since this was taken care of by the control in the pilot house. The electrical apparatus, of course, gave no indication whatever in regard to changes in load or reversal of speed in connection with the main motor, and the only indications that the engines gave that the load had been suddenly thrown on or off in maneuvering was the slight change in sound of the engines due to the slight change of speed. In fact, the ordinary observer in the engine room, unless he happened to be watching the electrical instruments on the switchboard, had no means of knowing that the boat was being maneuvered or, in fact, whether or not the main motor was running.

At the conclusion of her trials, the *Mariner* returned to her dock in New London and after some minor fitting out left on December 3 for Gloucester, where the winch and other gear for handling the trawls were installed.

Control of Main Motor

It should be stated that there is a controller in the engine room for handling the main motor, similar to the one in the pilot house, so that if desired the captain can give the usual gong signals to the engine room and the engineers can control the main motor with the controller there. The change from engine room to pilot house control is accomplished by simply throwing a switch on the engine room switchboard.

The fishing operations are carried on by means of a motor driven main double drum hoist, installed on the main deck forward of the engine room, which handles the haulage cables and ropes of the net as they pass through the hoist brackets fore and aft on either side. The unloading of the fish at the dock is accomplished by means of a motor-driven whip hoist located near the forward mast.

Cunard Liner Aquitania, Converted to an Oil Burner, Returns to Service

SINCE the end of November, 1919, the *Aquitania,* the largest vessel of the Cunard fleet, has been lying in the Tyne at the Walker yard of Messrs. Armstrong, Whitworth & Company, where her boilers have been converted to oil burners and she has been reconditioned for her regular transatlantic passenger service after her war service as an armored merchant cruiser, hospital ship and transport. The vessel sailed from Liverpool for New York on July 17.

Some idea of the magnitude of the job in converting this vessel into an oil burner may be gained from the fact that her boiler plant comprises 21 double ended Scotch boilers, each with 8 furnaces—making 168 furnaces in all—necessitating the laying of approximately 16 miles of piping with the necessary pumps, settling tanks and oil bunkers for handling 7,000 tons of oil. The oil is carried in the side bunkers, formerly used for coal, and also in six double bottom tanks especially fitted for this purpose.

Advantages of Oil Firing

With coal fired boilers there is always a considerable loss of steam on every watch through the burning down and cleaning of the fires. In the *Aquitania,* assuming 28 fires are cleaned every watch, nearly 8,000 horsepower is lost every four hours. With oil firing this loss is eliminated and constant steam pressure can be kept up, thus improving the speed of the vessel and the regularity of her service. Furthermore, owing to the fact that the temperature of the boilers can be maintained practically constant, the bill for boiler repairs will be materially reduced. With oil fuel it will be possible to bunker the vessel in about six hours without noise or dirt. The boiler room force will also work under incomparably better conditions in the stoke-hold and they will also gain in that special attention has been given to their accommodations. The rooms allotted to them form a new standard of comfort, cabins containing two, three or four berths each having been provided for each boiler room force.

Passenger Accommodations Improved

Many improvements have been made in the passenger accommodations during the reconditioning of the vessel, among which the following are noticeable: On *D* deck, in the reception room opposite the restaurant, a bank and inquiry office, or information bureau have been installed. To the swimming pool and gymnasium have been added a large sun bath room. The staterooms on the boat deck have been converted into one-berth rooms, each fitted with a bed and settee. The whole of *C* deck amidships has been rebuilt, the staterooms having been greatly enlarged, reducing the number to 32 rooms. Many of these staterooms now have private dressing rooms.

Here and There in the Shipping World

BY "OLD SCOTCH"

ONE of America's greatest shipbuilders told me several years ago that our husky cousin across the seas did not care such a great deal who built, owned and operated ships, so long as the "Tight Little Isle" could control the insurance. I did not take his remark seriously at the time, but from some of the cablegrams with London date marks which have been published recently, it seems that my shipbuilding friend was not so far off in his assertion as appeared at the time. When the threats that Lloyd's underwriters would positively refuse hereafter to assume any risks on American ships became widely circulated, they might have occasioned some alarm among the seafaring men of southern Indiana, but so far as I could judge from the faces of certain American marine underwriters whom I met at the time the threats were first hurled at us, it appeared that they were more amused than horrified. As a matter of fact, they *had* received cable advices from London underwriters discontinuing American business. In about three or four days, as the bluff did not seem to work at all, further cable advices were received stating that after mature consideration, etc., etc., American business in London would be resumed.

It was not the Jones bill, as popularly supposed, which put the English underwriters in such a spiteful frame of mind, but a piece of legislation enacted by the New York State Legislature previous to its recent adjournment, which required all foreign insurance companies admitted to do business in New York to file a statement of all American business done either here or at the home office, and pay taxes accordingly. Heretofore they have sidestepped much of the taxation which American companies have had to pay on similar business and hence have had a very decided advantage over domestic companies.

Insurance Syndicates Formed

Close on the heels of the London "strike" against America came the official announcement from the Shipping Board at Washington of the final signing of the contracts with the syndicates formed of all American marine insurance companies for taking over the insurance of all Shipping Board vessels and for underwriting the greater part of the risks on privately owned American merchant vessels. Syndicate "A" of this system is an underwriters' surveying organization to do for American insurance underwriters practically the same thing that the London Salvage Association does for English companies. This syndicate will be supervized by Charles R. Page, a former member of the Shipping Board, and more recently treasurer of the Atlantic, Gulf and West Indies Steamship Company. Mr. Page was for many years an official in the Firemen's Fund Insurance Company at San Francisco and is thoroughly competent to undertake the management of this important organization. Syndicates "B" and "C" are now in operation, and it looks as though for the first time in many years the bulk of the insurance on American vessels and cargoes will be written by American companies and the greater part of the $250,000,000 heretofore paid to foreigners annually for this purpose will be kept at home where it belongs. From the vigorous protests now being put up by several of our foreign maritime rivals, it looks very much as if the Jones bill is in reality what it was designed to be—a measure to encourage American shipping.

Shipping Developments Waiting for Shipping Board Appointments

At this writing, July 12, no action has been taken towards appointing the new Shipping Board provided by the Jones bill. As a result, shipping matters of all knds seem to have reached a standstill. So much depends upon the proper functioning of this new board that it is the uppermost wish in the minds of all persons interested in our new merchant marine that quick action be taken in making these appointments. Rumors as to the new personnel of this very important body are very numerous. Almost everybody who owns a yachting cap or who has been dubbed a "captain" is included among the possibilities for selection—that is, if we believe all the "inside dope" that is being handed out in shipping circles. It is but fair to assume that among so many aspirants, now that the salaries have been made somewhat commensurate with the duties to be performed, there should be no great difficulty in selecting commissioners who will measure up to the requirements. Let us fervently hope so, at least.

Disposition of the Leviathan an Important Problem

The disposition of the world's largest ship, the *Leviathan,* is one of the important matters awaiting the decision of this new board. When the bids for the purchase of this giantess were opened but one was received, and that in the sum of $3,000,000, with a request that if it be accepted the Government should make the purchaser a loan of $6,000,000 for reconditioning purposes and at the same time give the vessel free dockage during the extended period when the alterations would be made. As this sum is considerably less than the International Mercantile Marine bid for this craft, and as even that sum was considered grossly inadequate by the widespread publicity propaganda aimed against the sale of this fine vessel, it looks as if the board could not consistently accept the latest proposal. While $3,000,000 looks like a mere pittance for a ship which it is probable could not be reproduced under existing conditions for less than $25,000,000, there are attendant circumstances which, when taken into consideration, do not make that sum look so ridiculous.

The first of these is that ships of such herculean proportions and fast speed have never been looked upon as money makers, except possibly when considered as good advertising for the lines to which they belong. It will take a vast sum, estimated by some competent authorities as high as $10,000,000, to place her in first class condition for passenger service. Added to that, the vessel is now over six years old, and when her alterations are completed she will be at least seven years old. To the ordinary rules for depreciation, which would deduct considerable from her value, the fact that for over three years of her life she was tied up unused and not placed in a dry dock for painting her bottom must be given added consideration in appraising her present worth. In the more or less polluted waters surrounding Hoboken piers it is a safe gamble that her underwater plating must have deteriorated more than would ordinarily happen. Such a large vessel can only be used in one trade, and that is the North Atlantic passenger service, as nowhere else is there sufficient travel to promise full cabins, without which the loss would be tremendous. Little wonder, then, that only one bid was received, and it is not many organizations which would

have the nerve even to undertake the operation of such a vessel.

The most likely outcome therefore is that the Government will retain ownership of this, the largest vessel in the world. We, as Americans, like to boast of the largest of everything. Let us therefore retain this great ship as a souvenir of the world's greatest war, but by all means let us have her operated by some private organization. Capital cost and depreciation are the largest items in ship operation, and the Government can well assume these. In the meantime the revenue from this ship will keep her up in good shape and make it profitable to a private organization to operate her. For transport purposes in time of war she is a most valuable ship, and her continuance in Government ownership will make her immediately available as a war-time asset in preparedness. A ship such as she is, 927.6 feet long, 100 feet beam, 54,292 gross tonnage and 90,000 horsepower, will not very soon be exceeded in dimensions, from the present outlook, so that for some years, at least, we can regale ourselves that this, the greatest government on earth, is in possession of the world's greatest ship.

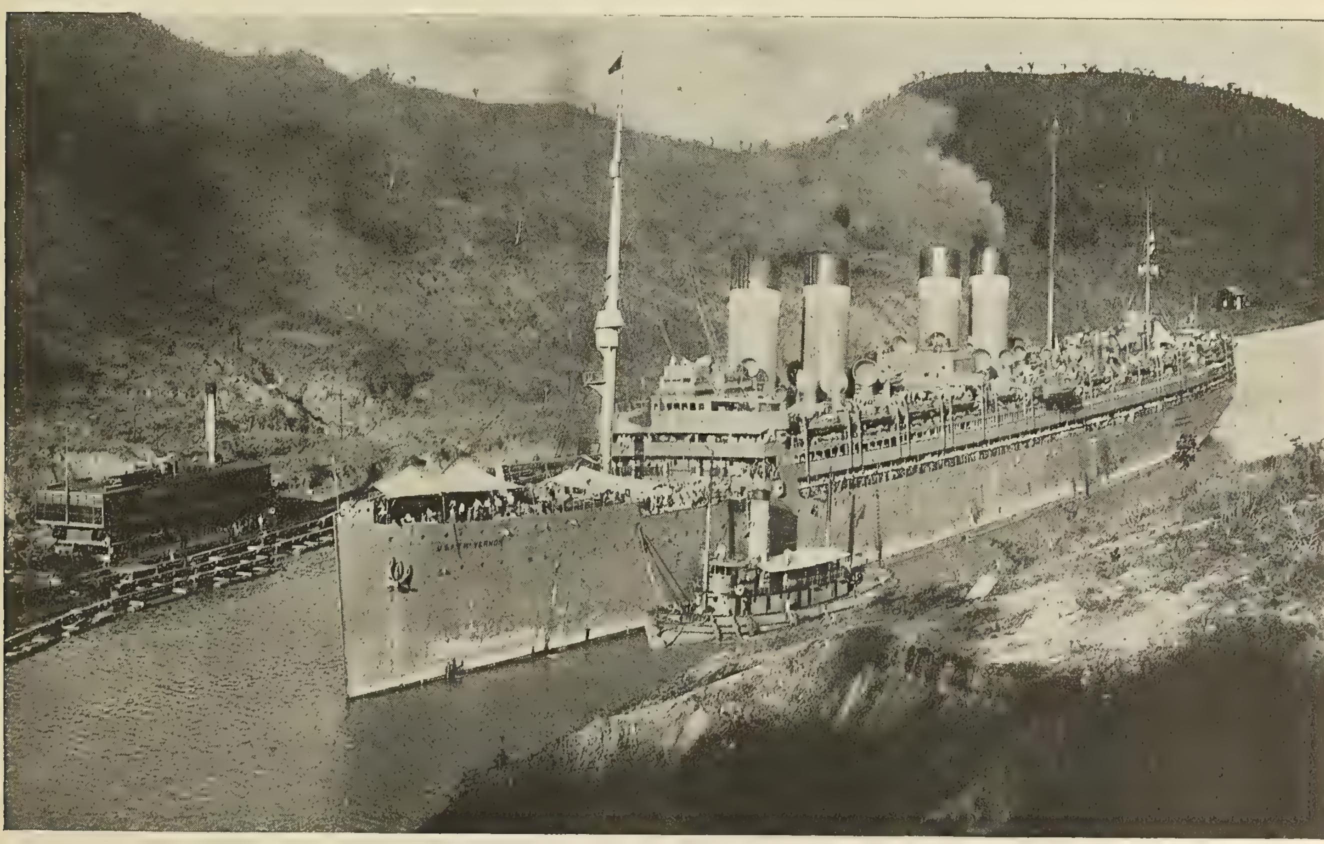
Prospective Shipbuilding Contracts

The dearth of new ship orders still continues, owing to the lack of a Shipping Board and to general uncertainties in the financial world. A clearing up of these conditions and the result of the forthcoming election settled will undoubtedly bring out a number of orders for new ships of special types. Among these are at least six new coastwise passenger ships about evenly distributed in number among the Admiral Line on the Pacific coast and the Red D Line and Porto Rico Line on this coast. Plans for those new craft are rapidly approaching completion. Undoubtedly some large motorships will soon be undertaken, as the prevailing prices of both coal and fuel oil make it economically imperative that we provide ourselves with ships that will use the smallest amounts of fuel for propulsion.

Pacific coast shipping people have been much perturbed of late at the threats of withdrawal from their ports made by certain foreign steamship lines, who took umbrage over the preferential rail rates authorized in the Jones bill on passengers and freight carried by American ships leaving our ports. They thought that they could circumvent this discrimination in favor of American bottoms by operating their vessels in the Pacific trade from Vancouver or other Canadian ports. Fortunately, the provisions of the Esch-Cummins transportation act recently enacted furnish the means for preventing such action on the part of our rivals, and Admiral Benson, the chairman of the Shipping Board, has made that fact known in unmistakable terms.

Both Political Parties Pledge Support of the Merchant Marine

It is interesting to note that the platforms of both the great political parties recently adopted in the national conventions contain planks pledging each to the upbuilding and maintenance of the merchant marine. One of the most encouraging things in connection with our national efforts towards the rehabilitation of shipping is that it has been free from partisan rancor. Each party, of course, claims originality of the idea, but as each has demonstrated its sincerity in the support of all measures looking towards the best interests of our maritime affairs, it makes but little difference to which party first honors belong. Let us conclude, therefore, that the movement is backed by the entire American people and that, in consequence, we are bound to succeed in our endeavor.



United States Army Transport *Mount Vernon* (formerly the North German Lloyd Liner *Kronprinzessin Cecilie*) Passing Through the Panama Canal on May 25, Bound from Vladivostock to Hamburg, via San Francisco and Norfolk. Except for the British Battle Cruiser *Renown*, This is the Longest Vessel to Navigate the Panama Canal

Shipbuilding Prospects in Russia

**Russian Merchant Marine Practically Non-Existent—
Material Resources and Shipbuilding Facilities of the Country**

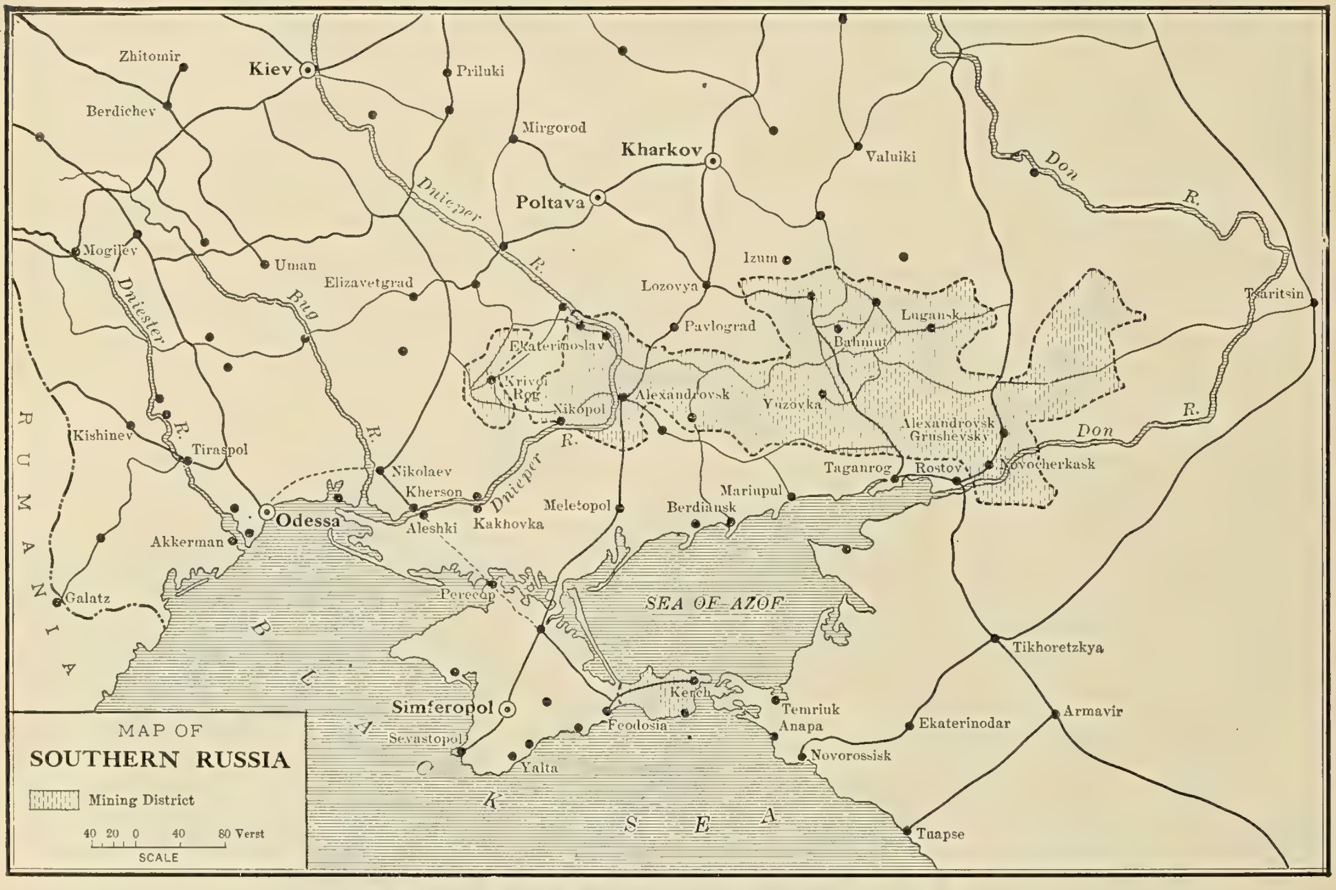
BY N. SETCHKIN*

DURING the war with Germany, Russia, on account of the difficulties of proper communication with the western allies, was unable to fulfill her tremendous national and military requirements with her own poorly organized industrial system. In spite of her very rich national resources, an economical crisis developed, and it was with difficulty that she recovered from her industrial shortcomings and consequent lack of technical equipment for the armies. As a matter of fact, this was accomplished only after she had suffered collosal losses of men at the front and by a gigantic overload through the use of poor mechanical equipment at the various shops. Social experiments of the Bolsheviki with nationalization of Russian industry, as well as the long continued blockade by the Allies, have brought Russia to a state of economical insolvency.

The majority of the works were forced to terminate operations, while the rest were not able to give one-tenth of their former production on account of the shortage of fuel and raw material, scarcity of machines and tools, as well as the lack of both organization and discipline in the shops resulting from the general state of civil war. Certainly this state of affairs cannot long continue. The cessation of naturally thriving industries cannot forestall the ever-increasing needs of a population requiring clothes, shoes, foodstuffs, machines, etc., and as soon as the blockade is lifted and trade with the rest of the world is resumed, Russian industry will immediately be restored.

The main problems for any Russian government, either democratic or soviet, will be the restoration of both interior and exterior transportation. According to recent information from Russia, a large army of labor specialists has been involuntarily transferred from the Red army to the water and railways for the purpose of putting the transportation machinery in order. New shipbuilding programmes are also mentioned for the river systems. Russia possesses comparatively good facilities of inland waterways on account of her large number of navigable rivers, which can be adequately utilized for the transportation of goods to and from the sea coast.

The next problem for the Russian government will be the re-establishment of the exterior transport system, i. e., the Russian merchant marine, which, as shown in Table I, was infinitely small. For instance, in 1914 Russia had only 600,000 gross tons of merchant shipping, which is equivalent to only 1.1 percent of the world tonnage, and she annually paid abroad $60,000,000 (£12,300,000) for freight alone. But at the present time the Russian



Map of Southern Russia, Showing Mining District and Principal Seaports

* Russian marine engineer.

TABLE I.—GROSS TONNAGE OF MERCHANT FLEETS OF VARIOUS COUNTRIES OF THE WORLD, 1914-1919, AND TOTAL LOSSES IN UNITS OF ONE THOUSAND GROSS TONS

	Countries	1914	Percent of World Tonnage	1919	Percent of World Tonnage	Regain + or Losses —	Percent of Tonnage
1	United Kingdom..	19,524	43.0	17,208	36.0	—2,316	—11.9
2	United States.....	2,027	4.5	9,773	20.4	+7,746	+382.0
3	Germany.........	5,135	11.3	3,247	6.8	—1,888	—36.8
4	Japan...........	1,708	3.8	2,327	4.9	+619	+36.3
5	France..........	1,922	4.2	1,962	4.1	+40	+2.1
6	Norway..........	1,957	4.3	1,597	3.3	—360	—18.4
7	Holland.........	1,472	3.2	1,574	3.3	+102	+6.9
8	Italy...........	1,430	3.2	1,258	2.6	—172	—12.0
9	Sweden..........	1,015	2.2	917	1.9	—98	—9.6
10	Austria-Hungary..	1,052	2.3	713	1.5	—339	—32.2
11	Spain...........	884	2.0	709	1.5	—175	—19.8
12	Denmark.........	770	1.7	631	1.3	—139	—18.0
13	Russia..........	498	1.1	541	1.1	+43	+8.6
14	Greece..........	821	1.8	291	0.6	—530	—64.5
	Other Countries...	5,189	11.4	5,149	10.7	—40	—0.8
	World Tonnage..	45,404	100.0	47,897	100.0	+2,493	+5.5

merchant marine practically does not exist because a great number of ships were taken over by the Great Powers since the Bolshevist revolution broke out.

As this war produced economical crises throughout all countries, the world tonnage for a long time will be unable to supply Russia on such a large scale as would be necessary for the immediate restoration of Russian trade and industry, which has a great influence on the lingering process of strengthening the Russian state. That is why it would be quite plausible to expect the inauguration of a large shipbuilding programme in addition to the construction of river craft.

Russia's Natural Resources

Russia possesses rich natural resources necessary for the development of its own shipbuilding, as can be seen from Table II, where is shown the coal and iron ore resources and the production and output in the principal countries. These figures are taken from data of the International Geological Congress of 1910 and 1913 (The Coal and Iron Ore Resources of the World) and from "The Mineral Industry," by G. A. Roush. According to this table Russia ranks third in the world coal resources, but, compared with other countries, the utilization of these resources was very poorly developed, and in regard to actual coal output Russia ranked sixth. Defective mechanical equipment and improper organization were largely responsible for the low per capita production. Professor Goldenstein in his book "Russia and Her Economic Past and Future" gives the following figures:

	Metric Tons
United Kingdom	6.0
United States	5.1
Germany	3.8
Belgium	3.0
France	1.0
Austria Hungary	1.0
Russia	0.2

Possibly as soon as Russia improves her mining equipment and organization, production will be increased on a large scale. In respect to iron ore deposits Russia ranked sixth, but it is necessary to point out that no extensive research was carried out before 1913. Later very large deposits were found in the Kertch district (Southern Russia) estimated at approximately 1,000,000,000 metric tons.

In addition to large amounts of coal and iron, Russia possesses a big reserve of copper, manganese, lead, silver, etc. In the production of copper Russia had in 1913 second place in the world production (42,970 metric tons), and in the production of manganese ore first place (1,171,000 metric tons).

During many years before the war only Russia's own

TABLE II.—NATIONAL COAL AND IRON RESOURCES OF VARIOUS COUNTRIES AND THEIR PRODUCTION DURING 1913 AND 1916

	Countries	Coal					Iron Ore		Pig Iron	
		National Reserve (Estimated)	Percent of World Reserves	Output During 1913	Percent of World Output	Output During 1916	National Reserve Estimated	Percent of World Reserves	Production 1913	Percent of World Product
		Mill. Tons.	Per-cent	Mill. Tons.	Per-cent	Mill. Tons.	Mill. Tons.	Per-cent	Mill. Tons.	Per-cent
1	United States	3,838,652	51.85	570	38.6	597	7,500	38.4	31.48	39.7
2	Germany.....	423,356	5.73	305	20.6	—	3,607	18.4	19.29	24.3
3	Russia.......	233,997	3.16	37	2.5	29	864	4.4	4.55	5.7
4	United Kingdom...	189,535	2.57	322	21.8	287	1,300	6.7	10.48	13.2
5	France.......	17,585	0.24	45	3.0	22	3,300	16.9	5.31	6.7
6	Belgium......	11,000	0.15	25	1.7	20	—	—	2.49	3.1
7	Austria Hungary	55,393	0.75	59	4.0	51	283	1.5	2.37	3.0
8	Sweden.......	114	—	—	—	—	1,158	5.9	0.58	0.7
9	Other Countries........	2,627,921	35.55	115	7.8	—	1,520	7.8	2.85	3.6
	World Total.	7,397,553	100.00	1478	100.0	—	19,532	100.0	79.40	100.0

resources have been utilized for the building of her warships.

Location of Russian Shipyards

The majority of the shipyards are located in Northern Russia, where there are, for instance, the Admiralty Shipyard, Baltic Shipbuilding and Engineering Works, Pootilof Works, Nevsky Works, Russo-Baltic Shipbuilding Company and Cryton Shipbuilding Company. At that time the advantages of Southern Russia could not be used for the development of shipbuilding on account of the lack of free passage from the Black Sea. That is why only two shipbuilding concerns, the Russian Shipbuilding Company and the Franco-Russian Shipyard are located on the River Bug about 40 miles from actual Black Sea water. These two yards were sufficient for building the required number of warships for the Black Sea navy.

The mouths of both rivers, Bug and Dniepr (see map of Southern Russia), are really the best places for shipbuilding in Southern Russia, because, in the first place, climatical conditions allow shipbuilding to be carried on about eleven months of the year, and, in the second place, these two places are located very near to the coal and iron mining districts, to which they are connected by railroads and waterways (the river Dniepr and the Black Sea and Asov Sea).

The river Dniepr is deep enough for navigation by steamboats up to the town of Alexandrovsk (about 150 miles); further up to the town of Ekaterinoslov many rapids interrupt the direct line of transportation. Before the war the Russian Ministry of Wars and Communication had plans to construct in this part of the river a dam and locks with the utilization of the water power of the river. According to this plan a water power station developing about 750,000-1,000,000 horsepower will be installed, with a small steam power station in reserve to take care of the low water period (2-2½ months of the year), when the power of the water power station is only about 200,000 horsepower. For this steam power plant scrap coal may be used which is not available for transportation to other parts of Russia. This cheap energy is intended to be supplied to all works and mines of this district, even to the shipyards.

Other lines of transportation from the mining district may be kept up by coasters going throughout Black Sea to Asov seaports such as Berdiansk, Mariupol and Taganrog, which are connected by railroads to the mines.

The Sebastopol Bay, as well as Kertch Bay, may also be successfully used for southern shipbuilding, but the

Asov Sea is not deep enough for ocean-going ships and its coast would be very unsuitable for such a plant.

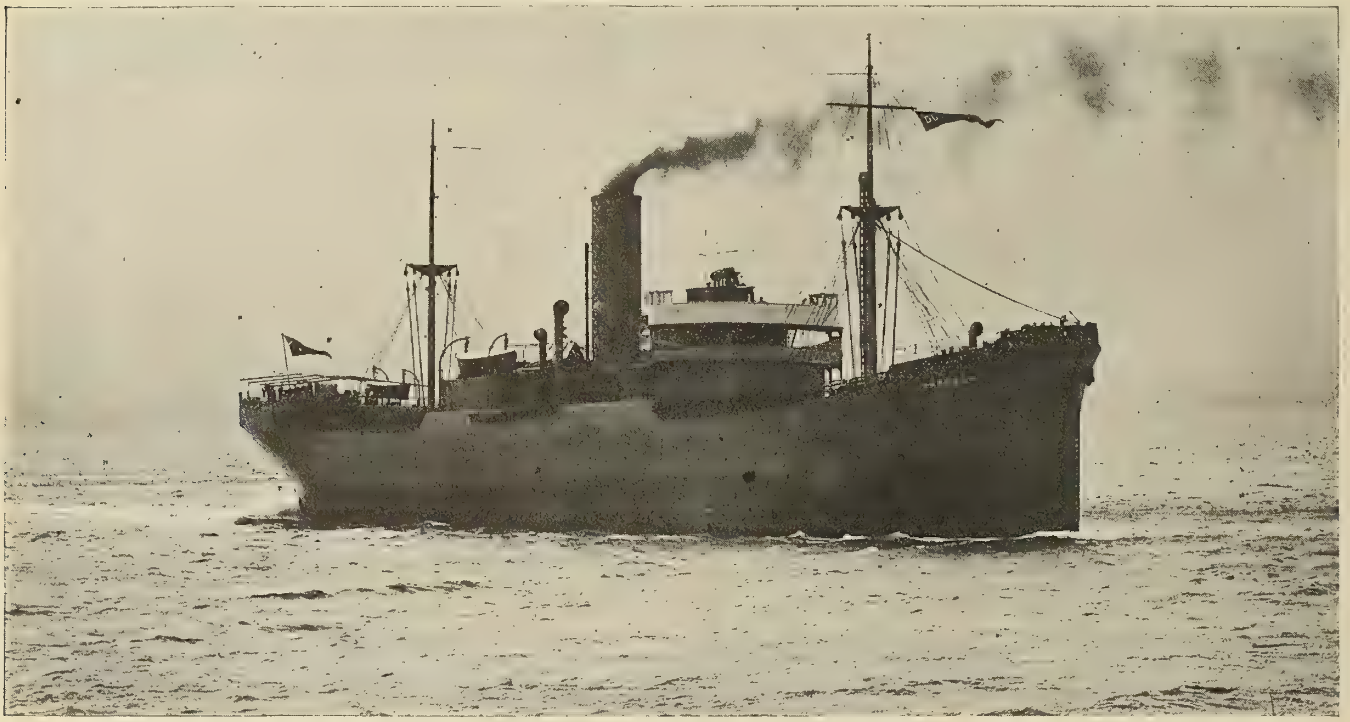
Practically all the Russian merchant marine has been built in foreign yards because without government protection the Russian yards were unable to withstand the competition of the foreign shipbuilding yards due mainly to lower costs and shorter time of delivery. But the Government at that time did not recognize the importance of this issue regarding Russian trade and industry and refused to give sufficient protection except in the case of building warships.

In 1913 and 1914 a company of Russian banks and metallurgical firms decided to take advantage of the excellent climatic conditions of the Black Sea, together with the neighboring centers of the metallurgical and coal industries, for the establishment of a shipbuilding plant in the south. The new company discovered that the time required for building Russian ships depended mainly upon the great delay experienced in procuring steel from the rolling mills, which were not accustomed to supplying the needs of shipbuilding concerns. On this account the new company decided to build simultaneously its own steel works, which could procure iron ore from its own mines and produce steel to meet the requirements of its own shipyard. Such an organization would greatly reduce the cost and time of building ships. Two concerns of this type were to be established in the near future, one on the river Dniepr, near the town of Kherson, and the other near the town of Kertch on Kertch Straits. According to the terms proposed by this company, construction of this plant was to be started within one year after the signing of the peace treaty and the expenditure on the plant in the first three years of development was to be not less than $1,300,000 (£267,000). These plans, however, did not materialize and were given up on account of the revolution.

At the present time Russian capital and industry have been harassed to such an extent that this plan would not be feasible in the near future without outside support. This problem of Rusian shipbuilding is so vitally important for Russian trade and industry, as well as for other countries which are desirous of obtaining grain and raw materials from Russia, that it is necessary for either government to take a hand in the settlement of this issue. However, neither will give liberal concessions to foreign companies for the development of the natural resources or for Russian shipbuilding.

German industrial interests displayed a long time ago great interest in the natural resources of the southern part of Russia, and during the occupation by the German army efforts were made to increase the production of these mines for their own uses. This interest has continued up to the present time, and they will continue to attempt to control the southern industrial business if the allied countries do not regard them seriously. Taking into consideration the huge success of American shipbuilding during recent years, it is evident that America could be a great competitor to any other country in the solution of this question because it would be easy for her to remove to Russia complete equipment of many shipbuilding plants which are now shut down due to the cancellation of contracts.

Nevertheless, it is certain that as soon as the blockade is removed and commercial relations are restored with the rest of the world, Russia will start to build her own merchant marine in order to attain the position among the sea powers corresponding to her rich natural resources and the requirements of her population and industry.



Australian Steamship *Dundula* on her Trial Trip

Progress of Shipbuilding in Australia

THE steamship *Dundula,* the fifth vessel to be completed under the Australian Commonwealth shipbuilding programme, ran satisfactory trials in Port Philip Bay, Victoria, on April 22. The vessel has a length of 341 feet, breadth 48 feet and a depth, molded, of 26 feet 1 inch. She is built on the Isherwood system of longitudinal framing, of the single deck type, with poop, bridge and forecastle, and is classed 100 A-1 at Lloyd's. She has exceptionally large hatches and ample cargo handling

equipment consisting of eleven winches and eleven derricks, including one 20-ton derrick.

The captain and officers are berthed amidships, the engineers being on the bridge alongside the engine casings. The crew is berthed in the poop. All accommodations are ample in size with separate mess rooms for the firemen and sailors, as well as baths and wash rooms.

The vessel will carry 5,600 tons deadweight on 21 feet 9 inches draft and was built at the Cockatoo Island Dockyard, whence she was towed to Williamstown for the installation of her engines, which were manufactured and installed by Messrs. Thompson & Company, of Castlemaine (Vic.).

The machinery consists of triple expansion engines with cylinders 25 inches, 41 inches and 68 inches diameter by 45 inches stroke, and three Babcock & Wilcox watertube boilers of 180 pounds pressure.

The *Dilga*, the third of the contract for six ships at Walsh Island Shipyard, has been completed and handed over to the Commonwealth authorities. On April 28 she steamed to Sydney, and on the next day was docked at Cockatoo Island for cleaning and painting. On the 30th her compasses were adjusted in Sydney harbor, and she steamed to Newcastle the same day, when speed trials were carried out, the vessel averaging 12.84 knots during three hours' continuous steaming. Turning trials were also successfully carried out.

China's Waterways*

BY A. H. HALLAM†

ONE often hears industrial China spoken of, but few people realize from a marine standpoint the vast possibilities that exist for the development of the thousands of miles of waterways that intersect this large continent and the facilities for trading that would exist by quicker and more efficient transport once these rivers and canals are opened up by the use of steam and motor driven vessels.

The present method, with but few exceptions, is by the use of man power on shallow draft wooden boats averaging 60 feet long and 12 feet wide. Two long oars called "Ulohs" working on metal mushroom pins at the stern, one on each side, propel these vessels, each manned by four Chinese, male or female. They give these oars a peculiar twist in operation, which compares with the movements of a steam driven propeller. Their speed under normal conditions is about 15 miles per day.

They also operate similar boats with a flat bottom, fitted with a stern wheel made entirely of wood, which is made to revolve by a number of Chinese stepping on wood blocks attached to the sides of the axle turning the wheel —on the treadmill principle.

This particular class of vessel is principally used on shallow draft rivers and canals, and many are noticed daily wending their way from Ichang up the gorges to Chun-King, a somewhat dangerous trip to make on account of the strong currents. The river between these two places is barely 90 yards wide, with very high mountains on either side. To give some idea as to the strong current here, it is interesting to note that it takes 10 to 12 days to reach Chun-King, but only 2 days to return from there to Ichang.

Recently steel shallow draft steamboats of the stern wheel type have been operated on this river with success, and doubtless as time goes on the old-fashioned boat will disappear.

In wooden boats no metal of any description is used in their manufacture, even the nails being of wood. Every boat built is constructed with watertight compartments down to the small "Sampans" carrying one or two passengers.

On the Yang-tze-Kiang river, as far as Hankow, large commodious river steamers operate daily from Shanghai. They are somewhat similar in appearance to vessels used on the Hudson.

There is also a large coast service of small but well-equipped steamers owned and operated by foreign and Chinese companies.

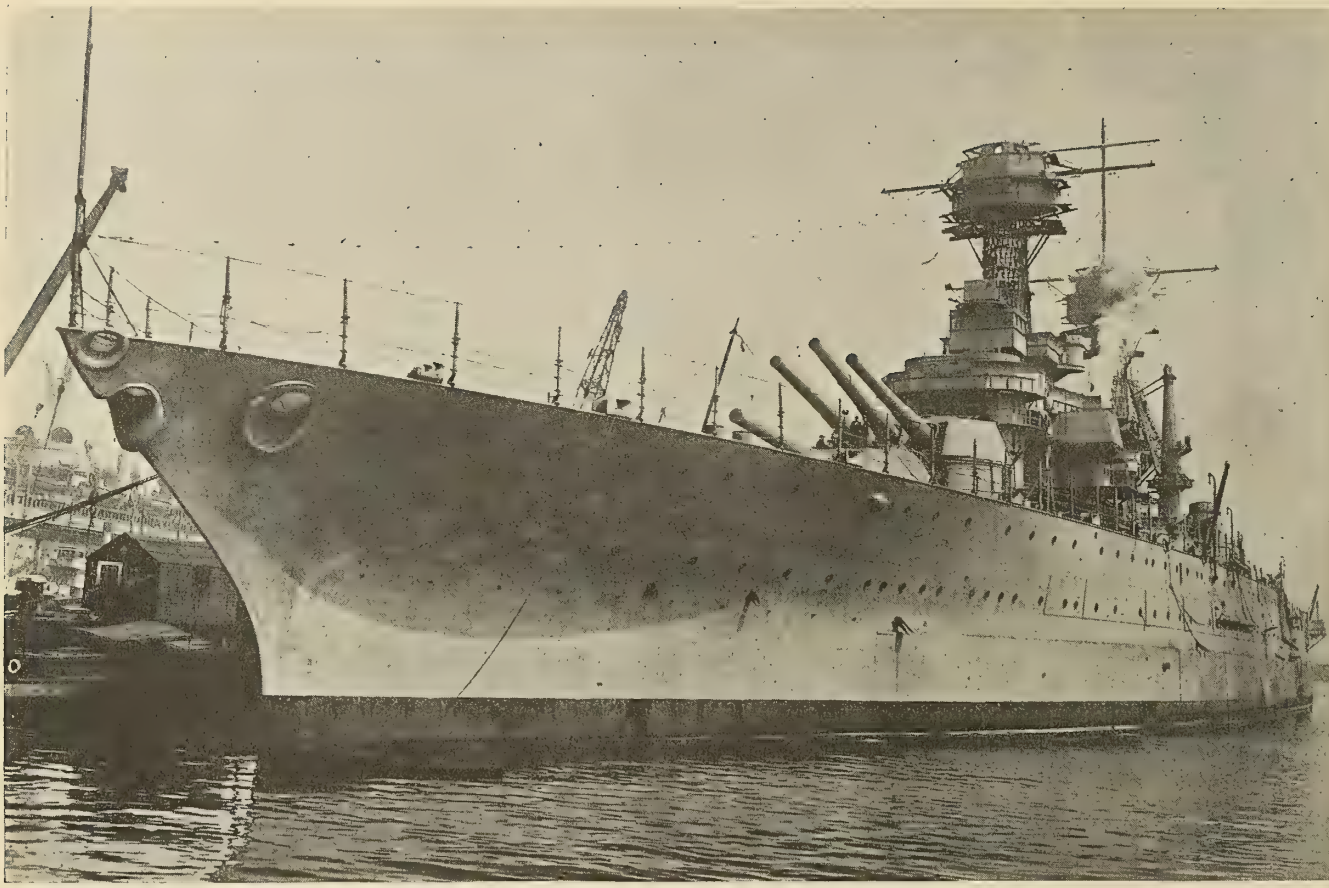
Fig. 1.—A Modern Passenger Boat on Canal near Pin-Kow

The Chinese as sailors and navigators are good, although their navigating instruments are home-made and crude. They venture to sea on long voyages on their large sea-going wooden junks. These trips are sometimes two or three months in duration. Their large bamboo masts slant in the opposite direction to ours—that is, at a forward angle of about 30 degrees forward instead of having a rake aft. The sails are fastened to long bamboos in the shape of blinds and are easily hauled up or stowed and reefed. The stern of these boats is built up very high in comparison to the bow and gives them the appearance of the ancient "galeon." There are hundreds of thousands of these junks sailing in Chinese waters, and not a single metal nail is used throughout their entire construction.

Fig. 2.—Looking Over Chun-King River. This Photograph Gives an Excellent View of this River's Boat Population

Such a boat has a large population, at times running into three generations, as it is the custom in China for the children to care for their parents in their old age. Most of these people are born afloat and will die without ever knowing what it means to live on shore. While civilization has made such progress everywhere else, it touches China very slowly, and present customs, most of them, in many instances were in vogue 2,000 years ago.

* From *The Compass*
† General manager of Vacuum Oil Company at Shanghai, China.



(Photograph copyright by Underwood & Underwood, New York)

United States Battleship *Tennessee*, Recently Commissioned at New York Navy Yard

The United States Battleship Tennessee

BY JAMES L. BATES

The United States battleship Tennessee, which went into commission on June 3, is the most powerful fighting vessel in the world today. She is 625 feet long, has a beam of 97 feet 3½ inches, and displaces 32,300 tons. Her main battery consists of twelve 14-inch guns, and she is protected by a heavy belt of armor. She is electrically propelled, her main engines consisting of two Westinghouse turbine generators, rated at 15,000 kilowatts each, and each of her four propellers is driven by an 8,000-horsepower Westinghouse motor. Her maximum speed with full power is 21 knots.

THE United States battleship *Tennessee* just completed at the New York Navy Yard, Brooklyn, N. Y., was, with her sister ship, the *California,* authorized March 3, 1915. The limit of cost for "hull and machinery" was $11,250,000. Her keel was laid May 14, 1917, she was launched April 30, 1919, and her total time of building covered a period of thirty-seven months. During a portion of this time it was impossible to push her construction on account of the volume of other war work of greater urgency.

The principal dimensions of the new fighter are as follows:

Length on waterline	600 feet 0 inches
Beam on waterline	97 feet 3½ inches
Mean draft, designed normal condition	30 feet 3 inches
Normal displacement, designed	32,300 tons

The armament of the *Tennessee* consists of twelve 14-inch, 50-caliber guns mounted in turrets, two 21-inch submerged torpedo tubes, fourteen 5-inch, 51-caliber rapid fire guns, four 3-inch anti-aircraft guns, and miscellaneous small caliber guns for boats, saluting and landing, together with the usual machine guns and small arms.

The turrets are of the latest three-gun type, all on the center line, two forward and two aft, placed in vertical echelon. This arrangement is now standard and has been adopted for nearly all capital ships of recent design.

The 5-inch guns are mounted on the upper and superstructure decks. They are placed well inboard from the vessel's side so as to be as free of water as possible when being operated in a sea-way.

Protection

The protection is arranged in accordance with recent American practice. A wide armor belt of great thickness extends amidships in way of the magazine, machinery and control spaces. A heavy, though narrower, belt extends aft in way of the steering gear. Heavy thwartship armor is fitted at the forward and after termination of the wide belt and at the after end of the narrower belt.

The protection of turret guns and conning positions is

very complete, both against direct hits and damage by fragments.

A heavy protective deck is fitted at the level of the top of the side belt, and a lighter splinter deck is worked a deck height below. These decks, together with longitudinal splinter bulkheads, have been so designed as to give excellent protection to the ship's vitals against the plunging fire to be anticipated in the long range actions of the present day.

A point of further interest in connection with the deck protection just noted is that it has been designed so as to form an effective part of the vessel's longitudinal girder and is of such thickness as to maintain adequate strength even after the structural strength deck next above has been entirely shot away. Such an arrangement of deck material also affords good protection against aerial attack, a matter of increasing importance at the present time.

Accommodations

The officers are quartered aft on the second and third decks. The crews are located amidships and forward on the main and second decks. The complement consists of 64 officers and 1,345 enlisted men and chief petty officers.

The vessels of the immediately preceding classes, the *Pennsylvania* and *New Mexico,* were designed for displacements of 31,400 and 32,000 tons respectively, although their lengths are the same as the *Tennessee* and their other dimensions do not differ materially from her's.

It will be seen from the foregoing that the *Tennessee* is of somewhat greater displacement than any other of the war vessels of the United States Navy now in commission.

Characteristics

Above water the *Tennessee* is typical of recent United States naval design for capital ships. She has the clipper stem intended to facilitate the stowage and handling of her anchors. Her upper deck extends from the stem to abaft amidships, at which point the main deck becomes the weather and extends as such to the stern. The stern is of the usual cruiser type common to most large war vessels. Forward, above the waterline, the vessel has a pronounced flare right out to the upper deck edge. This flare is carried forward to the stem.

Below water the vessel's form differs little from those of her immediate predecessors. She has the usual hard bilged midship section with wall sides and nearly flat bottom, but she has no parallel middle body such as has been used sometimes. Her prismatic and block coefficients are moderate and well suited to the conditions imposed. She has full forefoot sections below water, but a moderate angle of entrance at the load waterline. Her cross-sections are relatively slack forward of her forward quarter point, giving noticeably hollow waterlines at and below half draft. In the vicinity of the forward quarter point the hard midship bilge begins to take form. Aft the cross-sections are much cut away at the lower waterline, but the load waterline is kept relatively full. The keel is worked straight from forefoot to within 56 feet of the after perpendicular. This feature, together with the docking keels fitted in the way of heavy concentrated weigths, insures safety and facility in docking. Short bilge keels are fitted forward and aft in the vicinity of the quarter points.

Propelling Machinery

The propelling machinery consists of two turbo generators and four main motors driving four propellers. The maximum horsepower of the main motors is somewhat over 28,000. Steam is generated by eight oil burning Babcock and Wilcox boilers, each located in its own compartment. The maximum designed speed is 21 knots and the cruising speed 10 knots.

Oil fuel is carried in bottom and side tanks, so disposed as to provide an efficient protection against fragmentation in the event of successful torpedo attack.

Special Features

Particular attention has been given to the design and arrangement of conning positions and bridges in the light of the lessons of the recent war. This has resulted in the apparently cumbersome structure immediately aft turret No. 2.

Another feature given considerable prominence in recent United States naval design has been the ability of ship structures to withstand great hydrostatic pressure. The importance of this consideration has been emphasized repeatedly during the war, and the test heads to which the structure of the *Tennessee* has been subjected during construction represent a noteworthy advance over all our own previous practice.

The auxiliary machinery is in general electrical. This applies to turret turning gear, to elevating, ramming and shell hoisting gear, as well as to anchor handling, steering, boat and provision handling gear and ventilation. Oil burning ranges are used in the galleys, but the commissary appliances generally are electrical.

The following table places some of the leading characteristics of the *Tennessee* in comparison with those of certain battleships of Great Britain and Japan and with the United States battleship *Pennsylvania*:

	Pennsylvania	*Tennessee*	*Iron Duke*	*Royal Sovereign*	*Yamashiro*	*Ise*
Nationality	United States	United States	Great Britain	Great Britain	Japan	Japan
Length overall	608 feet	624 feet	622 feet 9 inches	624 feet 3 inches	630 feet	640 feet
Breadth, extreme	97 feet ½ inch	97 feet 3½ inches	90 feet 0 inches	88 feet 6 inches	94 feet	94 feet
Load draft	28 feet 10 inches	30 feet 3 inches	28 feet 0 inches	28 feet 6 inches	28 feet 6 inches	28 feet 4 inches
Displacement, tons	31,400	32,300	25,000	25,750	30.600	31,260
Fuel at load draft, tons	1,548	......	900	900	1,500	900-1,000
Coal capacity, tons	......	......	3,250	......	2,800	2,750
Oil capacity, tons	2,322	......	1,050	3,400	800	850
Shaft horsepower	29,000	28,000	29,000	40,000	40.000	45,000
Corresponding speed, knots	21	21	21	23	22½	23
Armament	Twelve 14-inch Fourteen 5-inch Two 21-inch T.T.	Twelve 14-inch Fourteen 5-inch Two 21-inch T.T.	Ten 13.5-inch Twelve 6-inch Four 21-inch T.T.	Eight 15-inch Fourteen 6-inch Four 21-inch T.T.	Twelve 14-inch Sixteen 6-inch Six 21-inch T.T.	Twelve 14-inch Twenty 5½-inch Six 21-inch T.T.
Main battery location	Four 3-gun centerline turrets	Four 3-gun centerline turrets	Five 2-gun centerline turrets	Four 2-gun centerline turrets	Six 2-gun centerline turrets	Six 2-gun centerline turrets
Date of laying keel	October, 1913	May, 1917	January, 1912	January, 1914	December, 1913	May, 1915
Date of completion	June, 1916	June, 1920	March, 1914	May, 1916	April, 1917	December, 1917

An examination of the above table reveals the following points of interest:

Great Britain put her last battleship of the conventional type into service four years ago, and since that time has built only capital ships of great speed. Both the United States and Japan have continued building the moderate speed battleships.

The latest types of battleship built by both Great Britain and Japan show increases of speed over the 21 knots which has been practically standard for the United States battleships since the *Delaware* class.

Great Britain, in so far as battleships are concerned, has not reached the large displacements which the United States and Japan have adopted.

Great Britain places less displacement on a given length than either the United States or Japan.

(*Concluded on page* 656.)

Famous Ships—The George Washington

BY CHARLES E. OLIVER

The problems of prompt transportation of troops after the United States entered the world war, and the seizure of the interned German liners for this purpose, have made the history of these ships of considerable interest, and among them none can have a greater interest in future marine annals than the historic and internationally famous ship which bore the President of the United States on his momentous errand at the closing of the great war.

DURING the early years of the present century up to the outbreak of the war in 1914, the Imperial German Government seems to have been actuated by the keenest ambition to cope with England so far as possible in the carrying trade of the world, and to this end encouraged in every way possible the construction of the wonderful masterpieces of the shipbuilding art carried out by the North German Lloyd and Hamburg-American companies. This resulted in such ships as the *Vaterland, Amerika, Kaiser Wilhelm II, Kronprincessen Cecilie* and others, as well as the building and improvement of great docks and piers in New York, Boston and other American ports. Another aim which Germany seems to have kept constantly in mind was the conciliation and good will of the United States, and the subject of this sketch was named in honor of Washington as a special compliment, being at the time of building the largest and most elaborately fitted ship ever built in Germany.

(Photograph by International, N. Y.)
The *George Washington*, With President Wilson on Board

The *George Washington* was built by the Vulcan Works, Stettin, Germany (Stettiner-Maschinenbau-Actien-Gesellschaft "Vulcan," Stettin-Bredow). The vessel was launched on November 10, 1908, and given her trial trip on June 2 of the year following. She made her maiden voyage June 12, 1909, her regular route being between Bremen and Hoboken, N. J.

The following dimensions, showing the size of this great ship, may be of interest:

Length overall	722 feet 5 inches
Length between perpendiculars	697 feet 6¼ inches
Length on waterline	700 feet 0 inches
Beam	78 feet 0 inches
Depth from upper saloon deck	54 feet 0 inches
Depth from awning deck	80 feet 0 inches
Draft	33 feet 0 inches
Displacement at above draft, tons	36,000
Horsepower	20,000
Speed, knots	18½
Revolutions per minute	83
Gross registered tonnage	25,570
Normal troop carrying capacity	5,175
Maximum persons carried on any single trip	7,121
Boat and life raft accommodations	9,128

She is a twin-screw passenger and freight steamer with a straight stem, semi-elliptical stern, two funnels and four pole masts. The hull, of steel with a double bottom for her entire length, is equipped with twelve watertight bulkheads, which divide the ship into thirteen watertight compartments. The screws are 21.33 feet in diameter and all her boilers are 15¾ feet in diameter.

When the United States entered the conflict, one of the first acts of war was to seize the interned German ships, among them the *George Washington*, then lying at her berth in New York harbor. Before it could be prevented it was found that the crews of several of these great ships, presumably acting under orders, had done serious damage to the engines by smashing parts of the high pressure cylinders in a way which the Germans supposed would make it impossible to replace or repair them for at least two years or for the duration of the war, thereby rendering the vessels useless either for transport or for other service.

On July 17, 1916, the *George Washington*, thus badly damaged, was towed from her berth in Hoboken, N. J., to the New York Navy Yard, under the orders of the United States Shipping Board, to see what could be done to repair the injuries to her engines. To the surprise of naval experts, and especially to the Germans themselves, American mechanical ingenuity was equal to the emergency, and by a process of electric welding of large steel castings the cylinders were completely repaired in a period of *three months.*

The trip which in the following year brought this ship into special prominence was the famous voyage which took the President and his party to Brest, France, soon after the signing of the armistice. On December 4, 1917, she steamed out of her berth in New York harbor under heavy naval convoy, with the battleships *Pennsylvania* and *Wyoming* leading under command of Admiral Mayo, together with the *Arkansas, Florida, Utah, Nevada, Oklahoma, New York, Texas* and *Arizona,* and amid the shrieking of innumerable whistles of every description and the greatest possible enthusiasm.

The President occupied the suite de luxe on C deck, staterooms 65 and 66, and on the entire trip was extremely interested in everything that occurred on shipboard, seeming fully to enjoy the much-needed rest and recreation which the trip afforded. The ship was under command of Captain Edward McCauley, Jr.

After an interesting voyage, the ship approached the French coast, where she was met by French and American destroyers and numerous airplanes, arriving at Brest about three o'clock on the afternoon of December 13. On the 14th, ten of the battleships started for the return to New York, and on the 15th the *George Washington* herself left Brest, having 331 officers and full crew, and with 3,461 returning soldiers, and arrived in New York on December 23. Of the returning soldiers about one-half were members of the famous "Cyclone" Division from Indiana, Kentucky and West Virginia National Guard troops, of whom 968 were wounded.

The second trip with the President began on the morning of March 5, 1919, when again the *George Washington* slipped from her berth on the north side of Pier 4 into New York harbor, accompanied by six destroyers and the battleship *Montana* as convoy. On this trip she was under command of Captain W. J. Bernard, and carried a crew of some 1,100 men. As she poked her way out into the stream the great guns from the surrounding warships thundered forth the Presidential salute of 21 guns, and from hundreds of harbor craft of all kinds came whistles and tooting as she was escorted out by many air craft.

Since her previous trip the ship had been painted throughout, and she was now equipped with new high-powered wireless apparatus with a radius of 1,100 miles. This precluded the possibility of wireless isolation as had occurred during a period of her former trip, when with a wireless radius of only 300 miles the President had been for several days entirely out of communication with Washington or the world. By the new equipment he was in constant communication with the station at Brunswick, N. J., until they could pick up the Poldhu Station on the other side of the Eiffel Tower. Passing quarantine about 9:10 A. M., this second trip was uneventful, and with an average speed of some 16 knots she arrived in about eight days at Brest on Thursday evening, March 13, on a beautiful moonlight night. At 9:45 the President disembarked for his trip to Paris, where he arrived the following morning.

Troopship Service

Beginning with her first trip on December 4, 1917, the *George Washington* made twenty-three round trips as a troopship between Hoboken, N. J., and Brest, France, up to the return from the first Presidential trip arriving at Hoboken on December 23, 1917.

At the present time she is undergoing extensive repairs at the Boston Navy Yard, preparatory to re-entering the passenger service. She is now under command of Captain William J. Ryan, and to him we offer our very best wishes in his future command of this interesting and splendid ship.

New Cunard Liner

Combination Type of Passenger and Freight Steamer for Transatlantic Service

William Beardmore & Company, Limited, recently launched from the Naval Construction Works, Dalmuir, the twin screw geared turbine steamer *Tyrrhenia,* which is being constructed for the Cunard Steamship Company, Limited, of Liverpool.

The *Tyrrhenia,* which is practically a sister ship to the *Cameronia,* which the Beardmore Company is now completing for the Anchor Line, Limited, has a cruiser stern, straight stem, one funnel and two pole masts.

Principal Dimensions

The principal dimensions of the vessel, which is of about 17,000 tons gross, are as follows:

Length overall	578 feet 6 inches
Length on load waterline	572 feet 6 inches
Length between perpendiculars	550 feet 0 inches
Breadth molded	70 feet 0 inches
Draft on load waterline	29 feet 0 inches
Depth molded to "C" deck	42 feet 9 inches
Depth from keel to boat deck	67 feet 9 inches

It is estimated that the vessel will be capable of carrying about 11,000 tons of deadweight at her designed draft of 29 feet.

General Arrangement

There are seven decks in all, namely, boat deck, A, B, C, D, E and F decks.

On A deck immediately under the boat deck are arranged the first class public rooms, consisting of lounge, smoking room, writing room, verandah café and gymnasium. These rooms are situated practically in the midship portion of the vessel and a little further aft are placed the second class lounge and second class smoking room. All these apartments are very spacious and will be handsomely furnished and decorated. On B and C decks, accommodation is provided for about 265 first class and 370 second class passengers in two- and four-berth staterooms fitted and furnished in every way to ensure the comfort of their occupants. A general room and a ladies' room for third class passengers are also provided on C deck.

On D deck amidships are placed the first and second class dining saloons with galleys, pantries, etc., between them. The first class saloon is capable of dining about 220 persons, and the second class about 300 persons at one time. Both of these apartments are very roomy and will be suitably furnished and decorated. At the forward and after ends of D deck sleeping accommodation is provided for third class passengers in two-, four- and six-berth cabins, and at the after end another general room and a smoking room for third class passengers are provided.

On E deck, practically amidships, are placed two large dining rooms for third class passengers capable of dining about 500 persons at one time, and in four other compartments on this deck sleeping accommodation is arranged for third class passengers in two-, four- and six-berth cabins, the total sleeping accommodation for this class being about 1,150 passengers.

Main Propelling Machinery

The machinery, which is supplied by the builders, consists of two sets of Brown-Curtis turbines, each set com-

prising one high pressure, one intermediate pressure and one low pressure turbine. Astern turbines are incorporated in each intermediate pressure and low pressure casing. The turbines drive the propeller shafts through helical gearing of the double reduction type.

Steam is supplied by three double end and three single end boilers, the double end boilers being 22 feet 6 inches long and the single end boilers 11 feet 6 inches long, the diameter of all boilers being 17 feet 6 inches. Howden's forced draft and superheaters of the smoke pipe type are fitted to the boilers, which are designed to burn oil fuel, but which can be readily converted to burn coal.

The machinery is capable of developing 13,500 shaft horsepower, and it is estimated that the vessel will maintain on service in moderate weather a speed of 17 knots.

A feature which will no doubt be much appreciated by passengers is the substitution of electro-hydraulic deck machinery for steam driven machinery. The steering gear, cargo winches and the windlass are all of the electro-hydraulic type, thus ensuring a minimum of noise and vibration due to the working of these auxiliaries.

The vessel is subdivided so as to ensure that she will float with any two compartments flooded, and special fireproof bulkheads are arranged to prevent the spread of fire in case of a conflagration breaking out on board. She will be equipped in the most up-to-date manner as regards cooking arrangements, sanitary accommodation, ventilation, heating, hospitals, wireless telegraphy and boat and life-saving appliances, and the comfort of the officers and crew has been specially considered.

The *Tyrrhenia,* which was designed by the Cunard technical staff, of which Mr. Leonard Peskett is the naval architect, is being built under special survey and classed 100 A-1 at Lloyd's. The vessel is constructed to comply with the British and American authorities' regulations in all respects as a passenger vessel and to the full standard of The International Convention for the Safety of Life at Sea.

Views of the Launching of the New Cunard Liner *Tyrrhenia* at the Naval Construction Works of William Beardmore & Company, Ltd.

New Graving Docks at Portsmouth, Va.

BY HARRISON S. TAFT*

(Published by permission of the Secretary of the Navy.)

During the past three years a vast amount of information covering various phases of our merchant marine has been furnished the public in the way of statistics and illustrations of its new ships and the yards in which they were built. Little has been said, however, about the necessary adjuncts for the preservation of our new vessels—the ship repair yards and dry-docking facilities. At the Norfolk Navy Yard three concrete graving dry docks, built on the arch type of construction, have been completed in record time under conditions that have made the work a noteworthy engineering achievement. How this immense project was carried through to completion in thirty-seven and one-half months and the details of the work are told in this article.

WHILE a great many new dry docks have been built in this country during the past few years, most of them have been of the "cradle" and "floating" type construction. However, it is fitting to state that several dry docks of the graving type have likewise been constructed, of a size far beyond anything ever attempted in the other types of structures, three docks of the graving type having been but recently completed at the Norfolk Navy Yard. While wooden or granite-lined structures have hitherto been the standard type adopted in this country for graving docks, the three new dry docks at the Norfolk Navy Yard are concrete monolithic structures built on the arch principle and represent what is virtually a new development in graving dock structures.

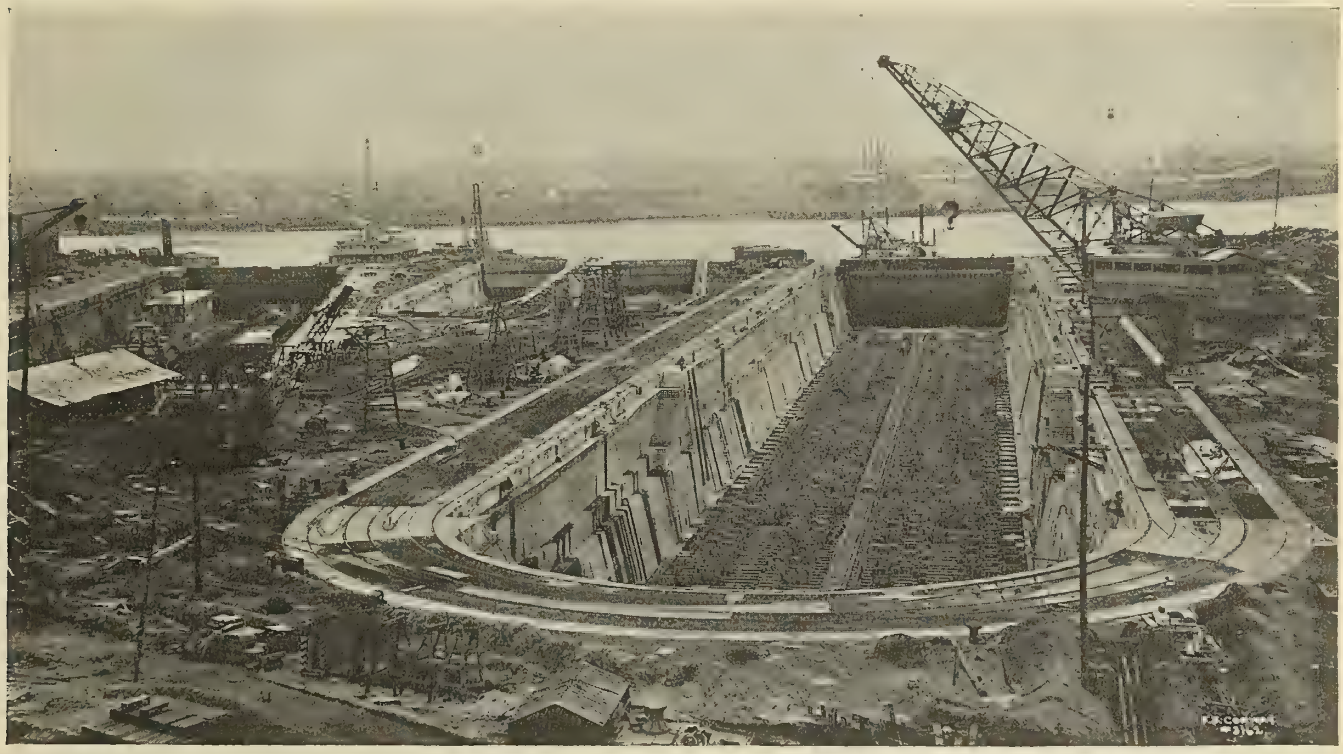


Fig. 1.—Dry Docks 4, 6 and 7, Taken from Top of Machinery Section of New Power House, Norfolk Navy Yard, During the Last Week of February, 1920

These docks were designed under the supervision of Rear Admiral F. R. Harris, U. S. N., and built by the George Leary Construction Company, George Leary, president; Fred H. Schonburg, vice-president; Harrison S. Taft and H. L. Mockemore, construction engineers

The Thousand-Foot Dry Dock

The most important of the three new dry docks recently built at Portsmouth, Va., is dock No. 4, designed by the Bureau of Yards and Docks, Navy Department, under the supervision of Rear Admiral F. R. Harris, along new and novel lines. This dry dock is without doubt the most complicated mass concrete structure ever built in this country. Measuring 1,000 feet in length from the outer caisson ring to the head wall of the dock, the dock has a width of 144 feet at its coping and a draft of 40 feet over the keel blocks at mean high tide. The height of the walls is 50½ feet. The minimum depth of the concrete floor is 20 feet. Around the top of the dock are three lines of standard gage track which afford access to all parts of the structure for the numerous yard cranes and for the new 75-ton crane built especially to serve this dock. A massive steel caisson closes the river entrance to the dock.

The flooding of the dock is accomplished by means of a large size tunnel built in the south wall, with numerous outlets through the wall into the dock proper as well as into the longitudinal drains built in the floor of the dock.

* General manager in charge of construction Dry Docks 4, 6 and 7, Norfolk Navy Yard, for the George Leary Construction Company, New York.

The pumping plant consists of three Worthington electrically-driven, centrifugal pumps situated at the bottom of deep wells in the south wall of the structure and of two smaller drainage pumps placed in a deep sump near the main pumps. All of these pumps draw water from a large suction chamber built in the base of the south wall, the roof of which forms the foundation for the three main pumps. The water flows through the floor drains, which run longitudinally the length of the dock into this chamber. The outer part of the flooding tunnel acts as a discharge passage for the pumped water, heavy sluice gates being provided to control the flow of the water in flooding and pumping out the dock.

A complete system of fresh and salt water pipes, as well as an air line and electric lighting system, extends around the dock inside of a tunnel which is built in the upper section of the walls to provide for a proper handling of the necessary work when ships enter the dock for painting and overhauling. Various flights of stairs and an elevator were provided to afford ready access to all parts of the structure.

In all 625,000 cubic yards of earth were moved and some 184,000 cubic yards of concrete poured in executing the work on this dock.

Details of the Smaller Docks

Dry docks Nos. 6 and 7 are twin graving docks built for the Emergency Fleet Corporation. They are each 471 feet long with a maximum width and depth to suit the vessels of our new merchant marine. At their river entrances both docks have steel caissons which are interchangeable.

These docks are flooded through six 24-inch valves in each caisson and through a tunnel built in the division wall. The tunnel extends in beyond the inner caisson rings and empties into both docks. A sluice gate is provided at the outlet of the tunnel to each dock. The longitudinal drains in the floor of each of these two docks are connected by large separate tunnels which exit in the floor of dry dock No. 4 with the suction chamber of dry dock No. 4; thus the pumps of dry dock No. 4 are used to pump out all three docks.

Standard gage tracks extend along the entire length of the two outside walls of each dock, while down the division wall is a 16-foot gage crane track which connects with a similar gage track that extends throughout the dry dock section of the yard.

Construction of Dry Dock No. 4

The construction of dry dock No. 4 involved engineering and construction problems of great magnitude. The excavation was done in the dry by two Bucyrus draglines, part of the material being carried out to sea on scows, the rest being used for reclaiming swamp land within and near to the Navy Yard and also for backfilling the concrete walls. The depth of the excavation in general was 72 feet below the original ground level, with a maximum depth of 92 feet. With the exception of the pump well section of the dock, the bottom of the excavated hole was bowl shape, the sides having a slope of 1 on 1, giving a width of cut at the ground level of about 375 feet. The top material consisted of ordinary earth and beach sand, the rest of the excavation being of blue clay and marl, resulting in a most satisfactory foundation for the concrete structure to rest upon. As but little water was encountered during the progress of the work, the conditions were almost ideal for carrying the project through to a rapid and successful completion.

In building the concrete structure, numerous devices and methods were utilized to hasten the work to completion. The first necessary step was to devise a "standard mode," as it were, for the construction of the entire dock (considered as a unit) in all its varying features and then to design "the concrete forms" to suit "the mode" adopted.

Thus it was possible to carry on the work from day to day in accordance with an adopted plan of procedure and not by trying to work along without any definite idea as to what was really necessary and needed for a successful execution of the work. By this method of procedure the entire organization knew far in advance the exact solution to be used as the work progressed (that is, as far as the human mind could foresee) and it was constantly working along one definite line to accomplish one definite result. This permitted the work to be driven at high speed to a rapid and successful completion, as it was found necessary to make but few changes in the "plan of procedure," all of which was foreseen far enough ahead to be properly provided for, each in its turn.

"Form-Work" and Method of Pouring the Concrete

The "form-work" involved in building dry dock No. 4 was of a most complicated and stupendous nature and called for the use of a vast amount of lumber. The floor of the dock has a minimum depth of 20 feet and was formed in one lift, the length and width of the forms being such as coincided best with the different parts of the design. The side walls were divided up into lifts of various heights as best to preserve the solidity of the structure. Many of the lifts were 28 feet high. One was 41 feet high, but the climax was reached when a wall form 51 feet 6 inches high and 60 feet long, containing 2,000 cubic feet of concrete, was erected and successfully formed as a true monolith, no interruption in pouring the concrete being permitted throughout the seven consecutive days it took to fill the form. The interior of this form consisted of complicated water passages, pipes, stairways and electric ducts, as well as steel reinforcement and anchor bolts with a concrete beam system for the railroad tracks running along the top of its entire length. The successful execution of this particular feature of the work was pronounced by engineers to have been one of the most audacious and stupendous pieces of form-work in the annals of the Bureau of Yards and Docks.

The concrete was mixed at the "mixing plant," located at the waterfront, all material being delivered in barges or scows. Two 2-cubic-yard mixers were used, the concrete being transported from the mixer to the top of the excavation in hopper cars drawn by locomotives and in general sent down steel chutes into the concrete forms. To meet varying and local conditions it was necessary to resort to innumerable methods in transferring the concrete from the hopper cars to the form, the drag line excavator at times being pressed into service in performing the operation where no other more economical method could be devised.

To provide a proper resting place for ships when placed in the dock, over 850,000 board feet of oak was secured to the concrete floor of the structure in way of the centerline and bilge keel blocking.

After the initial flooding of the dock in the presence of a large party of distinguished naval officers and citizens, the earth dike across the water end was dredged out by one of the largest dipper dredges on the coast, the massive caisson floated into place, the dock pumped out and made ready for docking its first ship.

While the task set for the engineers and the working crew in the construction of dry dock No. 4 was vast and difficult, in comparison the building of dry docks Nos. 6 and 7 was exceedingly simple, the only difficult part being

Fig. 2.—Dry Docks 6 and 7, from Top of Engineer's Office, Taken at Time of Dedication. Barley, Parsons & Klapp, Consulting Engineers

Fig. 3.—Dry Dock No. 4, Taken from Caisson During Last Week of February, 1920

in connection with the excavation, the pile driving and the water-soaked bank at the river end of the structures. A mode of procedure similar to that used in constructing dry dock No. 4 was adopted and the execution of the work carried out accordingly. The same machinery used in building dry dock No. 4 was employed, including the drag lines, the concrete plant, locomotives, etc., each for its special duty. The "forms" were of a very ordinary nature and almost childlike for the men to handle after their experience with those of dry dock No. 4.

As a steel cofferdam had been built completely around the water end of the two structures, no great difficulty was encountered in executing the work, although extreme care had to be exercised as the work approached the river-front, due to water conditions. Considerable ingenuity was also required in handling the excavation and driving the piles at the water end of the dry docks, because of the fact that, while it was impossible to operate the drag line in the usual manner, it was necessary to use it co-ordinately with a derrick in getting the steam hammer over some of the wooden piling at this part of the structures.

The initial flooding of docks 6 and 7 took place in the presence of the King and Queen of Belgium, who, with their full escort, attended the dedication exercises, the Queen acting as sponsor.

As the caissons for these two docks had been built at the head of dock No. 7, it was possible to put them in place and pump out dock No. 7 before the dredge removed the dike across the water end. Dock No. 6, therefore, remained full of water until there was a sufficient draft around the entrance to move its caisson from dock No. 7.

Construction of the Docks a Record Achievement

The construction of dry docks 4, 6 and 7 at the Norfolk Navy Yard under war conditions established an epoch in American engineering and contracting. Dock No. 4 was completed and ready for the docking of its first vessel—the battleship *Wisconsin*—26½ months after the beginning of excavation. Docks 6 and 7 were ready for their first ships 18 months after the beginning of their excavation. All three docks were completed and ready for use 37½ months from the starting of excavation on dock No. 4 in January, 1917. As the excavation work on docks 6 and 7 began seven months before the completion of dock No. 4, the unique situation of the simultaneous construction of three concrete dry docks by the same construction company and the same field organization existed, an event never before undertaken in this country (possibly not in any country). The above record will no doubt stand for many years before it is ever equalled or even approached, the record hitherto having been 4½ years for an 850-foot granite-lined dock built at the Puget Sound Navy Yard.

As government engineers and contractors in general are well informed from past experiences, graving dock construction ranks high among the list of uncertain and risky classes of construction work, the construction and fiscal failures in this class of work in the past in this country being notorious—so notorious that but few contractors have sought a second time to undertake such work. While many reasons exist in explanation of this fact, the principal ones are lack of exact knowledge of the underlying soil conditions and the risk involved therefrom, *inexperience in graving dock construction, improper methods of construction* and lack of capital and proper engineering skill. Other well-known items accompanying government contracts have each and all been contributory causes combined with unforeseen acts of nature and troubles too innumerable to record in certain cases. Thus the successful construction in record time under war conditions of three graving docks by the same construction company takes high rank among the engineering and construction achievements of the world war.

While granite-lined and wooden graving docks of increasing size to meet the increase in displacement of our war vessels have frequently been built by the Government in our Navy Yards, concrete graving docks are more or less of a new type of structure, especially where the "arch theorem" is used. In fact, as far as it can be ascertained, with but few exceptions, no such type of dry dock exists in this country outside of Government Navy Yards or stations, the only arch types being the three new docks at the Norfolk Navy Yard and the dock under construction at the Philadelphia Yard. Hence, very little data exist concerning the designing and construction of such types of structures except in government offices and among those who have been associated with their design and construction in responsible positions. Thus the record made at the Norfolk Navy Yard in the construction of dry docks 4, 6 and 7 stands out conspicuously in the annals of marine engineering work.

Standardization of Plain Limit Gages

A sectional committee of the American Engineering Standards Committee has just been organized to undertake the standardization of plain cylindrical gages for general engineering work, under the sponsorship of the American Society of Mechanical Engineers. The immediate occasion for undertaking the work was a request of the British Engineering Standards Association for co-operation on the subject. The committee held its organization meeting on June 11. It is understood that this committee will recommend to the American Engineering Standards Committee that the scope of the work should be broadened so as to cover all plain limit gages for general engineering work.

The present personnel of the committee is as follows: E. C. Peck, chairman, general superintendent, Cleveland Twist Drill Company; L. D. Burlingame, vice-chairman, industrial superintendent, Brown & Sharpe Manufacturing Company; H. W. Bearce, secretary, gage department, Bureau of Standards, secretary, National Screw Thread Commission; P. W. Abbott, Lincoln Motor Company; John Bath, president, John Bath & Company, Inc.; Earle Buckingham, engineer of standards, Pratt & Whitney Company; Fred H. Colvin, associate editor, *American Machinist;* W. A. Gabriel, chief draftsman and designer, Elgin National Watch Company; F. O. Hoagland, vice-president and works manager, The Bilton Machine Tool Company; Edward H. Ingram, works manager, The Cleveland Drilling Machine Company; J. O. Johnson, office of chief of ordnance, War Department; A. W. Schoof, gage engineer, Greenfield Tap & Die Corporation; G. T. Trundle, consulting engineer, Engineers Building, Cleveland, Ohio; H. L. VanKeuren, The VanKeuren Company.

Pipe Flanges and Fittings Standardized

The American Society of Mechanical Engineers has been requested by the American Engineering Standards Committee to assume sponsorship in the standardization of pipe flanges and fittings. In 1914 the society issued a report covering a schedule of pipe flanges and fittings for diameters from 1 to 100 inches for 125 pounds pressure, and also a schedule for extra heavy pipe, covering a range from 1 to 48 inches diameter and for 250 pounds pressure. In 1918 a supplementary report was published for working pressures of 50, 800, 1,200 and 3,000 pounds.

While the work has not been active during the last year, it is now proposed that it be continued, the society being formally recognized as sponsor, under the rules of the American Engineering Standards Committee.

Method of Estimating Steel Hull Weights

How Curves from Weight of Ships Already Built May Be Expanded and Curves Plotted for Various Divisions of Hull Steel

BY G. F. S. MANN, B. SC.

ESTIMATING has been described as an art, but it may be reduced to a science. The well-known method of plotting curves from the weight of ships already built may be conveniently expanded, and curves plotted for various different divisions of the hull steel. The advantage of this subdivision is, that the weights in each case are plotted against some factor which bears a different relation to the particular weight in question, so a very much greater accuracy is obtained in the curves than is obtained when the total hull steel is plotted against some one factor which endeavors to take into consideration all parts of the hull at once.

Classification of Vessels

Before the groups of weights are taken up in detail the method of classifying the subdivisions will be explained. All tankers are put in one class, which is then divided into multi-deck ships of full scantling, and shelter deck ships. Separate curves on different sheets are drawn for each of these groups. Freight steamers are in one class, divided into three groups, namely, full scantling ships of two or more decks, shelter deck ships and single deck ships. A further class contains combined freight and passenger ships, which are similarly divided into full scantling ships and shelter deck ships. Curves are plotted for each one of these kinds of ships and each ship has its weight divided into eight groups, as will be shown. The seventh group (miscellaneous items) has eight divisions in it.

Thus for each ship fifteen curves are drawn to show the weights of the different parts, and as we now have seven groups of ships (not taking into account the difference between transverse and longitudinal framing, which only affects certain groups of weights), there are in all one hundred and five different curves to be plotted to show the weight of these three classes of merchant ships.

The accompanying diagram, Fig. 1, shows the method of subdividing the weights in the case of a tanker, but the same method is applicable to any vessel.

The following subdivision of the hull has been tried in actual practice and has given useful results:

1. Keel and framing.
2. Shell plating.
3. Inner bottom plating.
4. Decks.
5. Bulkheads.
6. Foundations.
7. Miscellaneous.
8. Erections.

The first five of these groups, containing as they do all the strength members of the ship up to and including the continuous deck, will be considered in detail first. The weight of the keel and framing should be plotted against the factor $L\ (2B + D)$, for when dividing the weight by this factor it will be found that the coefficient obtained is nearly equal to the weight per square foot of the material in question. This follows, as $L \times 2B$ is approximately the area of the floors plus the keel, while $L \times D$ is found nearly to equal the developed area of the frames on both sides of the ship, from the inner bottom to the continuous deck.

The curves plotted for various types of ships show remarkable similarity, and also indicate that the coefficient of weight per square foot increases a little more rapidly than the size of the vessel.

In plotting the keel and frame item separate curves for transversely framed ships and longitudinally framed ships should be drawn on the same chart, where the actual advantage of one system in respect to weight over the other for any given size of ship is obtained directly by subtracting the ordinates of one curve from the other.

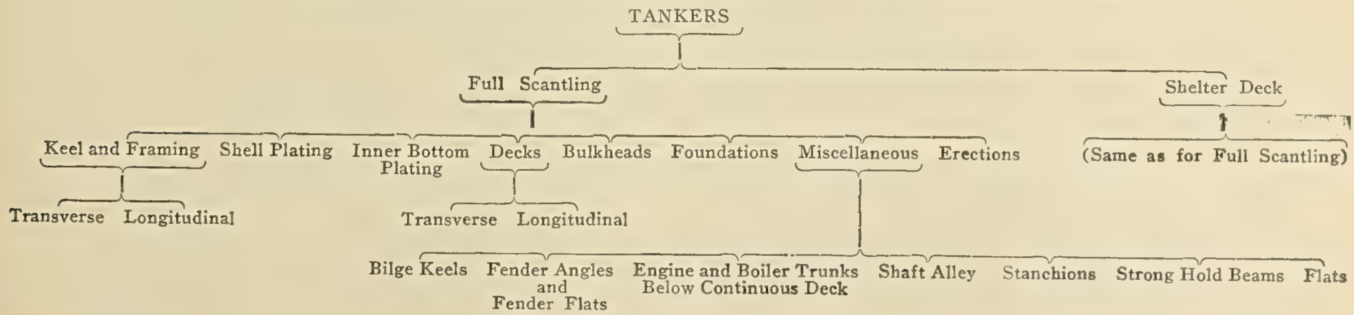
If the weight of the shell plating is plotted against the factor $L(B + 2D)$, it will again be found that the coefficient obtained by dividing the weight by the factor will be approximately the weight per square foot of the plating.

Similarly the inner bottom plating weight is plotted against the factor $l_{1b} \times B$, where l_{1b} is the length in feet of the inner bottom in question, and B the molded beam of the vessel. The breadth of the inner bottom is here assumed to be proportional to the beam, and while this is an arbitrary assumption it yet gives a means for comparison in different vessels, which is all that is here required.

Under the heading "decks" only the continuous deck (and the orlop, if any) are considered. Decks of erections should be taken in group number eight with the other erection weights. The weights of the decks should be plotted against the factor $B \times l_{dk}$, where l_{dk} is the sum of the lengths of the decks. As in the case of inner bottoms the term B in the factor is an arbitrary assumption, and used merely to give a definite basis for comparison. Curves for both systems of framing should be plotted in this group also, for the purpose of comparison as before.

In all ships, except oil tankers and molasses tankers,

FIG. 1.—DIAGRAM SHOWING METHOD OF SUBDIVIDING WEIGHTS OF TANKER



etc., the bulkhead weights are plotted against the factor $B \times D \times$ (number of transverse bulkheads). This is found to give a good basis for comparing weights. In the case of tankers where the longitudinal bulkheads have to be taken into consideration, the weights are plotted against $B \times D$ (equivalent number of bulkheads). The equivalent number of bulkheads is equal to the sum of the transverse bulkheads plus the figure obtained by dividing the length of the longitudinal bulkhead by B. That is to say the longtitudinal bulkhead is simply considered to be equivalent to so many transverse bulkheads.

It is difficult to find a logical basis for comparing the weights of foundations. Twin and triple screw ships are, of course, separated from each other, and also from single-screw steamers, and Lloyd's longitudinal numeral $L(B+D)$ is adopted as the factor against which to plot the weights, but the curves so obtained are very irregular, and are practically valueless.

Under the heading "miscellaneous" are a great number of items, and at first an attempt was made to plot the sum of these items against the factor $L(B+D)$ on the assumption that similar ships should have similar weights of miscellaneous parts. However, this assumption proved to be quite wrong, and so the miscellaneous group is now divided into the main subdivisions shown below.

(a) Bilge keels.
(b) Fender angles and fender flats.
(c) Engine and boiler trunks below continuous decks.
(d) Miscellaneous trunks and ducts.
(e) Shaft alleys.
(f) Stanchions.
(g) Strong hold beams.
(h) Flats.

When subdivisions (a) and (b) are separately plotted against L, fairly uniform results are obtained.

Subdivision (c) is plotted against $B \times D$, which also gives useful results.

Similarly subdivision (d) is plotted against $B \times D$.

Subdivision (e) is plotted against L_{sa}, when L_{sa} is the length (or in the case of more than one screw the sum of the lengths) of the shaft alley, and the results obtained show this to be a fair assumption.

The rest of the miscellaneous items are each plotted against $L(B+D)$, but, with the exception of the case of stanchions, the results obtained are poor.

In the eighth main group it was at first attempted to plot the erection weight against $B(l_p + l_b + l_f + \ldots)$, where l_p represented the length of the poop, l_b the length of the bridge, etc. The curves were not as uniform as thy should have been, and it was necessary to modify the factor and use the summation of $B_pl_p + B_bl_b + \ldots$ etc. B_p, being breadth of poop, B_b breadth of bridge, etc. When this is done fair curves are obtained.

In all cases the weights are plotted as ordinates, and the proportional factors as the abscissae. The curves are all found to bend toward the ordinate, showing that the scantlings increase more rapidly than the size of the ship.

When the somewhat arduous work has been done, and the elemental weights of the different members of various types of vessels classified in the manner described above, the designer has at his disposal a very complete and handy set of data for quickly estimating the weight of any new vessel.

Of the older methods in vogue, the best known was called the "Cubic Number" method. This consisted in taking a coefficient for the entire vessel, as follows:

$$\frac{L \times B \times D}{100 \times \text{weight of steel}} = \text{cubic number.}$$

This cubic number was fairly independent of the size of the vessel ranging from .40 to .44 for transverse vessels, and from .38 to .42 for longitudinally framed vessels. Here, however, the scientific accuracy of the new method herein described is missing and the omission of decks, bulkheads, etc., had to be allowed for by the experience of the designer.

In the case of firms having considerable data in the form of weights of vessels actually built, the method which was formerly employed was that known as the "off and on."

When a new design was under consideration the scantlings were reduced to a "straight Lloyd's" scantling. A type vessel was similarly reduced and the weight of the two vessels compared. Such data as the weight of 10-foot length amidships, and of 1 inch difference in depth or beam, were previously calculated for the pattern vessel.

Experience has shown, however, that the "elemental method" described in this paper is the most accurate and the most foolproof of all former methods.

Testing the Hull Structure of Ships—III

Rules and Methods for Testing Chain Lockers, Shaft Tunnels, Decks and Deck Erections, Cargo Oil Compartments and Cofferdams

BY F. K. RUPRECHT

TEST NO. 14.—CHAIN LOCKERS

Note.—Often the chain locker is built into the fore peak tank and is hence tested at the time of the test on this tank. Should, however, the fore peak not be arranged to carry ballast, or if the chain locker projects into the No. 1 cargo hold or, in fact, any other compartment, it is required to test it to insure that in the future no damage to cargo or stores or vessel itself will result from the leakage of this compartment. The chain locker is provided with drain pipes draining into the bilges or direct to the pump lines. If the chain locker is provided with drain holes so as to drain directly into some compartment, as the fore peak, for example, it need not be tested.

(a) *Object*

To test tightness of the chain locker and drain pipe connections thereto.

(b) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

No specific requirement.

2. British Lloyd's Register.

No specific requirement.

3. Bureau Veritas.

No specific requirement.

(c) *Procedure of Testing*

Test before painting with bitumastic or other composi-

tion, and after all work within and adjacent to chain locker has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to launching date or other contingencies, the final approval of the test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a re-test obligatory.

Fill the locker with water to a depth of about two feet over the bottom, after plugging the drain pipe or shutting the valve in the drain line. The bottom of the tanks and the sides, where under water, and the drain pipe connections should show no leak under this head. Any leaks or defects developed should be made good by legitimate means and all to the satisfaction of the surveyor.

Test No. 15.—Shaft Tunnel

(*a*) *Object*

To test watertightness of shaft tunnel, thrust recess and tunnel recess flat.

(*b*) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

To be tested with a hose after all work affecting the tightness has been completed, the pressure of the water in the hose being not less than 30 pounds per square inch. The test is to be carried out under simultaneous inspection on both sides of the plating.

2. British Lloyd's Register.

To be tested upon completion with a hose, the pressure of water in the hose being not less than 30 pounds per square inch, under simultaneous inspection on both sides of the plating.

3. Bureau Veritas.

To be tested with a hose. (Note.—No minimum pressure is specified.)

(*c*) *Procedure of Testing*

Test before cementing, cement washing or painting with bitumastic and before fitting ceiling and after all work within and adjacent to the tunnel has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to some contingencies, the final approval of the test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a re-test obligatory.

Direct a stream from a hose under the required pressure of not less than 30 pounds per square inch upon the outside of the tunnel in a systematic manner, taking each side and top separately and working fore and aft or vice versa, so as to test all seams and butts, boundary angles, column foundations and all other riveted connections. The speed of progress with the hose and the method of advancement is to be so regulated as to permit the surveyor on the inside to inspect all parts thoroughly. No leaks should show up under this test, but if any are found they are to be made good by legitimate means all to the satisfaction of the surveyor.

Test No. 16.—Freeboard Deck

Note.—The freeboard or bulkhead deck must be calked and made tight whether covered by a watertight superstructure deck or whether exposed throughout or exposed partially. If the decks are of wood or wood sheathed, they are nevertheless to be tested in a like manner.

(*a*) *Object*

To test the watertightness of the freeboard deck casing and house coamings and all connections to the deck, to insure the seaworthiness of the vessel and to insure that in heavy weather no water will enter the hold to damage cargo, machinery, fuel oil or the vessel itself.

(*b*) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

To be tested with a hose after all fittings are fastened in position. The water pressure in the hose is not to be less than 30 pounds per square inch.

2. British Lloyd's Register.

To be tested with a hose. (Note.—No minimum pressure is specified.)

3. Bureau Veritas.

No specific requirement.

(*c*) *Procedure of Testing*

Test before painting with bitumastic or coating with cement or other deck composition and before any internal sheathing in quarters or other compartments is fitted, and in the case of wood decks or steel decks wood sheathed, after all seams have been calked and payed and after all work on deck has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to some contingency, the final approval of the test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the deck will make a re-test obligatory.

Clear the deck of all loose dunnage and direct a stream from a hose under the required pressure upon the deck in a systematic manner so as to test all seams, butts and riveted connections as well as the foundation clips, mast connections, hatch coamings, manholes, pipe connections and all other fittings. The speed of progress and method of advancement is to be such as to allow the surveyor on the under side to keep pace with the impinging stream. The deck should be absolutely tight under this test, and any leaks which may develop should be made good by legitimate means, all to the satisfaction of the surveyor. In some cases it may be desirable or convenient to test the deck by plugging up the scupper and blanking off the freeing ports and flooding the decks to a depth of 12 to 18 inches. This gives a very good test under the proper conditions.

Test No. 17.—Forecastle, Poop, Bridge Decks; Complete or Partial Superstructure Decks; Awning and Shelter Decks

Note.—All decks exposed to the weather are to be calked, whether of steel or wood or wood sheathed.

(*a*) *Object*

To test the watertightness of all decks, companionways, hatch coamings, skylights and trunks exposed to weather, and all casings to house coamings to insure the comfort of the crew and passengers and the safety of the cargo from damage due to water.

(*b*) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

To be tested with a hose after all fittings are fastened in position; the water pressure in the hose is not to be less than 30 pounds per square inch.

2. British Lloyd's Register.

To be tested with a hose. (Note.—No minimum pressure is specified.)

3. Bureau Veritas.

No specific requirement.

(*c*) *Procedure of Testing*

Test before painting with bitumastic or coating with cement or other deck composition and before any internal sheathing in quarters or other compartments is fitted, and after all work on deck has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to launching date or other contingencies, the final approval of the test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a re-test obligatory.

Clear the deck of all loose dunnage and direct a stream from a hose, under the required pressure, upon the deck in a systematic manner so as to test all seams, butts and riveted connections as well as foundation clips, mast connections, hatch coamings, manholes, pipe connections and all other fittings. The speed of progress and method of advancement is to be such as to allow the surveyor on the under side to keep pace with the impinging stream. The deck should show absolute tightness under this test, and any leaks which may develop should be made good by legitimate means, all to the satisfaction of the surveyor.

Test No. 18.—Forecastle, Bridge and Poop Fronts; Sides and Fronts of All Exposed Deck Houses, or Erections, Including Engine and Boiler Casing

Note.—Forecastle, bridge and poop fronts to be of a substantial construction and be made watertight; all exposed deck houses are also to be of ample strength and be watertight, as are to be the engine and boiler casings, where exposed to weather, or where protected by a non-watertight structure. Houses and casings which are a good distance above the load waterline and are not subject to blows of seas, etc., need not be tested. This latter question is one for the judgment of the surveyor.

(*a*) *Object*

To test the water and weather tightness of all erections exposed to weather to insure the comfort and safety of the crew and passengers, and in the case of the engine and boiler casings, the safety of the machinery, and in the case of the bridge and poop fronts, the safety from damage of the cargo, and in all cases, the safety of the vessel itself.

(*b*) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

No specific requirements.

2. British Lloyd's Register.

No specific requirements.

3. Bureau Veritas.

No specific requirements.

(*c*) *Procedure of Testing*

Test before coating with bitumastic or other solutions and before fitting any internal sheathing and after all work within and adjacent to the structure has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to launching date or other contingencies, the final approval of the test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a re-test obligatory.

Direct the stream of water from the hose under a pressure of about thirty pounds per square inch against the structure to be tested in a systematic manner so as to test the seams and butts, angle and all other riveted connections, watertight doors, cargo ports, port holes, pipe connections and all other fittings. The speed of progress with the hose and the method of advancement are to be so regulated as to permit the surveyor on the other side to inspect all parts thoroughly. No leaks should develop under this test, but if any are found, they are to be made good by legitimate means, all to the satisfaction of the surveyor.

Testing of Bulk Oil Corners

Note.—The testing of oil corners will not differ from the tests given in the preceding section except in the case of the cargo oil tanks and cofferdams. The tests for the latter two are given separately.

Test No. 19.—Cargo Oil Compartments

(*a*) *Object*

To test the oiltightness and strength of the transverse boundary bulkheads, the centerline bulkhead, the shell in way of the tank, the deck forming the crown of the tank, the longitudinal bulkheads forming the sides of the expansion trunk, the deck forming the top of the expansion trunk, all manholes, hatches and hatch covers and all pipe connections to decks, bulkheads or shell.

(*b*) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

To be tested before launching or when in dry dock with a head of water at least one foot above the highest point to which oil has access in pipes, hatchways or elsewhere; or to a head of not less than six feet above the highest point of the expansion trunk, whichever is the highest.

2. British Lloyd's Register.

To be tested before launching or when in dry dock with a head of water eight feet above the highest point of the expansion trunk.

3. Bureau Veritas.

To be tested before launching or when in dry dock with a head of water eleven feet above the crown of the tank or four feet above the expansion trunkway hatch covers, whichever is the highest.

(*c*) *Procedure of Testing*

Test before launching and before painting, except that a light coat of red lead on the shell is permissible, but bulkheads and decks should be uncoated, and after all work within and adjacent to the tank has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to some contingency, the final approval of the test cannot be given until such workmanship has been passed. Any finding of the inspector which makes necessary work which may affect the tightness of the structure will make a re-test obligatory.

Fit a standpipe onto the crown of the tank or hatches (vent pipe may be used) and carry the pipe to the prescribed height, fitting a large funnel or other container at the top, the height of which is to be such as to show the level of the water when at the testing head. No leaks or defects should develop at this pressure, and any found

should, of course, be made good by legitimate means to the satisfaction of the surveyor. Often it is not possible to test completely before launching, and in this contingency it is necessary to have a preliminary test to insure the tightness of the shell in way of the tank. In this case the tank is filled with water to a level well up into the expansion trunk in a two or more deck vessel, and nearly to the deck level in a single deck vessel with an exterior expansion trunk, and the shell made tight under this head to the satisfaction of the surveyor.

Since these tanks will carry oil, and in view of the fact that oil is more searching than water, the surveyor's inspection of workmanship and test will be most rigid and a superior job will be insisted upon throughout.

Test No. 20.—Cofferdams

(*a*) *Object*

To test the oiltightness and strength of the transverse boundary bulkheads, the centerline bulkhead, the shell in way of the cofferdam, the deck forming the crown of cofferdam, the longitudinal bulkheads forming the sides of the expansion trunk, the deck forming the top of the expansion trunk, all manholes, hatches and hatch covers and all pipe connections to decks, bulkheads or shell.

(*b*) *Classification Societies' Rules*

1. American Bureau of Shipping and British Corporation Registry.

To be tested before launching or when in dry dock with a head of water at least one foot above the highest point to which oil has access in the pipes, hatchways or elsewhere; or to a head of not less than six feet above the highest point of the expansion trunk, whichever is the highest.

2. British Lloyd's Register.

To be tested before launching or when in dry dock with a head of water to the top of the hatchway.

3. Bureau Veritas.

(No specific requirement differentiating between cargo oil tank and cofferdam.)

To be tested before launching or when in dry dock with a head of water eleven feet above the crown of the tank or four feet above the expansion trunkway hatch covers, whichever is the highest.

(*c*) *Procedure of Testing*

Test before launching and before painting, except that a light coat of red lead on the shell is permissible, but bulkheads and decks should be uncoated, and after all work within and adjacent to the cofferdam has been completed and the workmanship has been inspected and passed by the surveyor. If it is necessary to test before the surveyor has inspected the workmanship, due to some contingency, the final approval of the test cannot be given until such workmanship has been passed. Any finding of the inspector's which makes necessary work which may affect the tightness of the structure will make a re-test obligatory.

Fit a standpipe onto the crown of the tank or hatches (vent pipe may be used) and carry the pipe to the prescribed height, fitting a large funnel or other container at the top, the height of which is to be such as to show the level of the water when at the testing head. No leaks or defects should develop at this pressure, and any found should, of course, be made good by legitimate means to the satisfaction of the surveyor. Often it is not possible to test completely before launching, and in this contingency it is necessary to have a preliminary test to insure the tightness of the shell in way of the tank. In this case the tank is filled with water to a level well up above the waterline (about the same level as used for testing the shell in way of cargo oil tanks) and the shell made tight under this head to the satisfaction of the surveyor.

Since these cofferdams are part of an oil-carrying vessel, the surveyor's inspection and test will be most rigid and a superior job will be insisted upon throughout.

When testing to Lloyd's requirements it is to be noted that no standpipe will be required and the cofferdams in this case need only be tested with a head of water to the top of the hatch coamings.

Note.—It is usual to subject the pump rooms to the same test as the cofferdams.

In speaking of repairing leaks, the term "legitimate means" has been frequently used. To the experienced shipbuilder this term will have a very definite meaning, but to the less experienced, judging from jobs I have personally seen, this term will have no meaning at all. Some of the present-day so-called shipbuilders, i. e., car and barge and bridge builders, consider any means as legitimate. Below will be found some of the things which are not legitimate. It should be noted that this is not a complete list, since new and devious means are invented or resurrected from the graveyard every day.

1. Calking the heads of panhead or button head rivets, or calking the points of button or snap pointed rivets.
2. Ring calking rivets, i. e., instead of calking a rivet into the countersink to try to calk it into the solid plate by scoring a deep ring into the plate around the rivet.
3. Calking pieces of packing and waste into a joint.
4. Calking in dutchmen where the heel of the bar is off, due to poor beveling.
5. Calking loose or defective rivets.
6. Welding where re-calking has failed to make the job tight.
7. Painting with bitumastic and other heavy paint.
8. Cementing.
9. Applying "Smooth On" or other patent composition.
10. Re-calking a bar where it is seen that the leg stands off the plating.
11. Re-calking a seam which shows by the depth of calking that it was not originally drawn up tight before riveting.
12. Red lead gunning without the permission of the surveyor.
13. Calking sheet lead or wire lead or sheet steel into a seam, butt, corner or under the heel or toe of a bar.

This, when all summed up, means that testing time is not the time to patch up a bad job. A poorly done piece of work usually requires drastic action before entire satisfaction can be obtained, and it is better to tear it out and replace than to spend a long time trying to patch it up. Of course, minor leaks can usually be fixed up rather easily, but serious ones, or minor ones from a serious cause, always require the renewal of some part and reriveting. It should be noted that a well done piece of work never gives serious trouble on test except in cases of poor design, and I have found that time and time again a poor job is only made worse by monkeying with it, so that it is always cheaper in the end to face the issue and make the job right rather than following the path of least resistance and doing as little as possible. This latter is a policy for which the highest officials of the company are often directly responsible. It is admitted that a poor job can often be made temporarily tight and pass the test, but ships should be built to go to sea—not to dry dock.

It is hoped that the foregoing list of tests will show how important a subject the testing really is. Time and money can be saved in shipyards by planning the work so as to arrange for tests in a logical order, and an attempt should be made to give the "testing gang" the proper opportunities to prepare the various tanks for test in a predetermined order and at dates so fixed that it will be unnecessary to postpone the launching day, trial day or any of the other "critical dates."

There is annexed a table of static pressure due to various heads of salt and fresh water. This table has been figured to only one place in decimals, since for ordinary testing work this is sufficiently accurate.

TABLE OF WATER PRESSURES

Head in Feet	Pressure in Pounds per Square Inch — Fresh Water	Salt Water
1	.4	.4
2	.9	.9
3	1.3	1.3
4	1.7	1.7
5	2.2	2.2
6	2.6	2.6
7	3.0	3.1
8	3.5	3.6
9	3.9	4.0
10	4.3	4.4
11	4.8	4.9
12	5.2	5.3
13	5.6	5.7
14	6.1	6.3
15	6.5	6.7
16	6.9	7.1
17	7.4	7.6
18	7.8	8.0
19	8.2	8.4
20	8.7	8.9
21	9.1	9.3
22	9.5	9.7
23	10.0	10.3
24	10.4	10.7
25	10.8	11.1
26	11.3	11.6
27	11.7	12.0
28	12.1	12.4
29	12.6	12.9
30	13.0	13.3
31	13.4	13.7
32	13.9	14.2
33	14.3	14.5
34	14.7	15.0
35	15.2	15.6
36	15.6	16.0
37	16.0	16.4
38	16.5	16.9
39	16.9	17.4
40	17.3	17.8
41	17.8	18.3
42	18.2	18.7
43	18.6	19.1
44	19.1	19.7
45	19.5	20.1
46	19.9	20.5
47	20.4	21.1
48	20.8	21.5
49	21.2	21.9
50	21.7	22.4

The United States Battleship Tennessee

(*Concluded from page* 643.)

The British vessels carry less fuel when in the normal or trial condition than do the vessels of either the United States or Japan.

The *Tennessee,* it will be noted, is 900 tons greater in displacement than the *Pennsylvania,* the first of our 30,000-ton battleships. Although larger in displacement, the advance in propelling machinery has made it possible for the *Tennessee* to attain the same steaming radius as the *Pennsylvania* upon less oil fuel. This, together with the 900 tons increase in displacement, has made practicable the fitting of more complete torpedo protection, individual turret gun mountings in lieu of the single slide type, 50-caliber, 14-inch guns instead of the 45-caliber type, and the modern type of bridge and superstructure.

Sheet Metal, Salt Air, and Rust

BY BENNETT CHAPPLE*

SALT air and the variations of temperature along the seaboard, because of the severe corrosive conditions, leave the marine engineer continually face to face with the great problem of rust. He knows that salt air and moisture stimulate an electrolytic action among the impurities of steel and that on this account the deterioration of ordinary sheet metal is rapid. Instead of a normal, uniform oxidation, the metal flakes and crusts under the action of the elements like the loose bark of a tree.

The first real effort to combat the rust problem with high quality sheet metal was the manufacture of a pure iron in commercial quantities by the American Rolling Mill Company, Middletown, Ohio, which produced what is known as the Armco brand of American ingot iron. Before this time the cost of pure iron was prohibitive for general use. When placed upon the market it attracted attention, because the theory that iron would resist rust in proportion to its degree of purity seemed to be borne out by the chemical and metallurgical tests of old iron that had resisted the ravages of time.

Millions of dollars are spent each year in sheet metal replacements along the seaboard, so that the engineers who have designed and constructed docks and warehouses on both the Atlantic and Pacific coasts have made a special study of the cause and prevention of corrosion. The engineers who built the Savannah docks at Savannah, Ga., the municipal pier at San Francisco, and the great Curtis Bay coaling station at Baltimore, were among the first to adopt pure iron because of its rust-resisting properties. The construction of the Cristobal and Balboa coaling stations in the Panama Canal zone under government engineers was another instance of the selection of pure iron instead of steel for sea coast construction in order to eliminate the danger of rust. The Dravo Construction Company, Nevills Island, Pittsburgh, Pa., was one of the first to adopt galvanized American ingot iron in the construction of dredges and hoist and mixer boats. Several of these boats were placed in service in 1913, and after six years of hard service it is said that the iron plates and fixtures show no signs of deterioration. It is also interesting to note that in the Ford *Eagle* patrol boats, which were under construction during the war, American ingot iron was used exclusively in smokestacks, boiler casings, stokers, sheathing, cowls, lockers and shaft casings.

In heavier plates American ingot iron is used for deck plates and safety treads. It has proved suitable for all sorts of sheet metal or plate work on board vessels where a tensile strength of less than 44,000 pounds is required and where corrosion is to be combated.

The United States Steamboat Inspection Service has given very careful consideration to the subject and has recently approved pure American ingot iron as qualified to meet the government specifications for charcoal iron in lap welded boiler tubes. In marine welding, pure iron has been found to be well adapted as a filler, both in speeding up the operation and in maintaining the uniformity of welds. In this connection the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., after investigating various grades of welding materials, adopted pure iron as giving the most satisfaction.

* American Rolling Mill Company, Middletown, Ohio.

The Repair Equation in the Future of the American Merchant Marine

BY WALDON FAWCETT

That facilities for ship repairs, no less than resources for ship construction, are requisite to the upbuilding of an adequate and creditable United States merchant marine, is a fact that has all along been apparent to experienced and practical men in the maritime industries, but which has only been brought home to the general public in consequence of the hearings and investigations incident to the formulation and enactment of the new merchant marine law. It has been made clear, indeed, that the capabilities of American agencies for ship repair may dictate the development and distribution of the nation's shipping, even more surely than will the capacity of American shipyards gage the volume of additions to the merchant fleet.

THE American conscience, which has lately been so remarkably quickened with reference to the merchant marine, has but to hark back to the experiences of the steel navy of the republic to find convincing evidence that ship repair facilities should keep pace with, if not outstep, vessel construction. Time and again in the history of the United States Navy has there been consternation in official circles, when it was discovered that a new naval building programme called for battleships of dimensions not to be accommodated in any existing dry dock. Even more recently, as illustrative of the influence of the repair factor, there was observed the feeling of unrest and uncertainty that was created in American shipbuilding circles when reports were circulated to the effect that the United States Navy Department would attempt to carry on all repair work on the Government fleet at navy yards.

Congress Investigates Ship Repairs

The most interesting information that has been adduced with respect to the post-war conditions in the United States in the field of ship repair and reconditioning operations has lately been brought out as a result of first-hand investigations in various cities by a select committee of the House of Representatives delegated to make an investigation of the activities of the United States Shipping Board. In its quest for information this Congressional commission has consulted at length with various officials, and notably with Mr. Robert Lyons Hague, formerly of the United States Shipping Board Emergency Fleet Corporation. Mr. Hague, a naval architect, who is now with the Standard Oil Company of New Jersey, has recently held the position of Director of the Construction and Repair Department, in charge of all repair and reconditioning work, including the letting of contracts.

In an outline at Washington of the practice of his office, Mr. Hague made it clear that in the reconditioning of the ships (cargo, cargo and passenger, or passenger vessels) turned back by the War Department as the military need relaxed, it was the policy of the Shipping Board to let contracts as the result of competitive bidding and in most instances to make contracts direct rather than through agents. An exception was made, however, in the case of the *Leviathan,* formerly the *Vaterland* of the Hamburg-American Line, in the case of which a contract* was entered into with the International Mercantile Marine to act as agent in connection with the reconditioning work. Explaining why an intermediary was desirable in connection with this record-breaking repair job, the Fleet Corporation's executive in charge of repairs said:

Reconditioning the Leviathan

"The *Leviathan,* which is the largest vessel in the world, presented to America the most difficult problem that has ever been put before the American merchant marine in the way of reconditioning. Nobody in this country, outside of the International Mercantile Marine, had the experience in big ships that was so necessary in a job of this magnitude. For the Government to have gotten together the skilled force necessary, providing they could have gotten them together—because practically all the leading talent is engaged or connected in some way or other with different enterprises—would have been an enormous expense and we considered it a great waste of time." Incidentally, Mr. Hague revealed that as a prelude to preparations for reconditioning an effort was made to obtain from Germany the original plans of the *Leviathan.* "We cabled the builders to quote us a price on a complete set of blue prints for that ship," he related. "As I remember, they quoted us $1,000,000."

To shipbuilders and shipowners who have occasion to conduct negotiations involving repair work, the details of the contract between the Emergency Fleet Corporation and the International Mercantile Marine Company may be of interest. Under this compact the International Mercantile Marine was to receive as compensation for agency representation the sum of $15,000 per month from the time of the commencement of the services until the steamer went to her berth for loading. And subject to the sale of the vessel the owner further agreed to assign the *Leviathan* to the agent for operation and management for a period of five years from the time that the vessel goes on berth for loading, terms to be agreed upon.

Contract with the International Mercantile Marine

The primary service to be performed under this contract by the agent in charge of repairs consists in supervision of the preparation of plans and specifications for the reconstruction, repairing and outfitting of the *Leviathan,* these plans and specifications to belong, of course, to the owner. In order to execute the commission entrusted under the contract the agent agreed to contribute on its account, so far as may be necessary, the services and office expenses of its executive officers, including chief and assistant chief of construction, chief inspector, chief draftsman, superintendent engineer, marine superintendent, passenger and freight experts, victualing superintendent and clerical assistants. Officers and crew and personnel for the maintenance of the steamer were to be employed by the agent for the owner's account and there was also reserved the right to employ, with the approval of the owner's representative, technical experts, the latter subject to discharge

* Now that the Shipping Board is trying to sell the *Leviathan,* it is a question whether this contract will be carried out.

on the written request of the owner or his representative. The agent is by the contract empowered to enter into contracts for materials, machinery, equipment, supplies, etc., but all purchases in the amount of $5,000 or over and all contracts are subject to the approval of the owner.

An exchange of views with respect to repair work, that is not without significance with respect to ship repair work in general, was conducted incident to the formulation of a programme for the *Leviathan*. This took the form of a round-table conference attended by representatives of leading American shipbuilding and repair firms. The first question that came up at that conference was whether in the case of a repair job of indefinite nature it is possible to obtain from repair interests a lump sum price. On this point J. W. Powell, vice-president of the Bethlehem Shipbuilding Corporation, said: "I think, if I would do the job, I would split it in two parts. I would do as much as was reasonable to do on a fixed price basis—coal burning change to fuel oil, electric lighting, plumbing, etc.—and the rest on a cost-plus fee basis." Mr. Powell further suggested that, if desired, the work could be divided into certain big items, as, for example, the fuel oil installation, and that each of these items could be handled on a fixed price basis, leaving the other items to go on the cost-plus plan.

Cost-Plus vs. Lump Sum Basis

An opposite view regarding the possibilities of the administration of repair work was taken by W. F. Gibbs, chief of construction of the International Mercantile Marine Company. His idea was that with the exception of oil fuel installation, great difficulty was bound to be encountered in subdividing repair work. Granted that such operations as plumbing, ventilation, electric installation, interior communication and joiner work must proceed as a whole, it would be bound to beget complications to have a number of firms operating simultaneously. Mr. T. Ross, repair manager of the Newport News Shipbuilding and Dry Dock Company, was one of the participants in the conference who opposed the adoption of the cost-plus plan for repair work of the character of that on the *Leviathan*. He declared that adoption of that formula "would be demoralizing to the shipbuilding business." Explaining the limitations that exist in ship repair work, he commented: "The difficulty most repair people have in doing jobs on a fixed sum is not in giving a definite price on the work as specified, but it is difficult to estimate on your general clauses. The difficulty comes when working out. General clauses in reconditioning jobs give the difficulty in so far as definite quotations on missing parts are concerned. Sometimes these are taken care of in a separate item. If done on that basis, I do not see why a contractor should not be able to get it on a lump sum basis."

An incident of the reconditioning operations on the *Leviathan* that has attracted some attention in shipping and shipbuilding circles involved the construction and installation of "sample staterooms." Given a feeling of uncertainty as to just what was desirable in the form of interior appointments on the ship, it was concluded that rather than risk the expense of revisions and alterations of joiner work it would be preferable to construct several sample staterooms which would permit the executives to form opinions from actual inspection rather than to depend on plans alone for guidance. Accordingly, several "sample" staterooms were constructed at commercial rates, the thought being to provide the repair firm that should ultimately be given the contract with a model or standard room.

That bids for repair or reconditioning work must, of necessity, vary between limits, depending on whether the bidder submits his bid for the items specifically stated or whether the intent of the specifications as clearly implied be bid upon, is the theory of Lieutenant-Commander F. S. Crisp, general work superintendent, hull division, New York Navy Yard. Explaining this principle for the benefit of the special Congressional committee, the naval specialist said: "In the case where it is necessary to refit a ship, it is almost impossible in my opinion to detail specifically every single item of work that is to be done, and the specifications usually written covering this class of work state that the work is to be done, say, in accordance with the best commercial practice or in accordance with the approval of the person awarding the contract. The painting of a bulkhead would be a simple example—where it cannot be definitely decided whether the bulkhead must be scraped to the bare wood or whether the painting may be done without scraping. In the case of refinishing woodwork, it is quite impossible to state whether all woodwork is to be removed, and it is usually stated that all woodwork that is necessary shall be renewed. The person bidding on the clause in the contract would necessarily have to use his own judgment as to just how far the work should be renewed.

"Again, in the case of overhauling plumbing or piping it is not usually possible to specify in detail just what sections of pipe or what particular valves are to be overhauled, and it is therefore customary to write the specifications to cover only the general overhauling of such and such a system, such as a sanitary system. The person bidding will necessarily examine a number of sections of pipe or a number of drain lines, and will base his bid on the general condition of the ones which he actually examines."

Preparation of Plans and Specifications

"The problem of the preparation of plans and specifications for extensive repair or reconstruction work has been the subject of considerable discussion in the course of the Congressional investigation of Shipping Board operations in the repair field. On one occasion the chairman of the special committee asked Mr. Hague, director of construction and repairs, whether in the case of the reconditioning of the *Leviathan* the Shipping Board would not have saved money if it had procured the original plans, even though it was necessary to pay the German builders the demanded sum of $1,000,000 for a complete set of blue prints.

"We would not have affected any saving whatsoever," was the declaration of the head of the repair department. "With the original plans in hand we would still have had to have taken—unless we scrapped everything in the ship and put in a complete installation—the pains of finding out the actual condition of the various parts that are integral in a passenger ship, such as ventilation, plumbing, heating, wiring, etc. We would have had to go to the trouble of making a survey of each of these individual items to satisfy ourselves as to their condition, or we could have taken the original plans, scrapped everything, and duplicated them. To my mind the means taken was far more efficient and far less expensive, for, with an expenditure of approximately $300,000, we obtained plans and specifications ready to secure a bid. Now, even though we had paid a million dollars for the detailed plans from Germany, we would still have had to go to the expense of making a survey as we have done."

Capacity of American Ship Repair Plants

Incident to the Congressional inventory of the Shipping Board's practices and policies with respect to repair work, there has been considerable discussion of the capabilities

and capacities of American plants for ship repair work. In this discussion, Shipping Board officials have actively and steadily defended the principle that, even at the risk of seeming discrimination, it is the part of wisdom for the shipowner or operator to entrust his repair work only to plants whose ability to execute all that they may undertake is unquestioned. On this score, Director Hague, on one occasion, said: "It is rather a serious question whether you want to give, on a government contract, an opportunity to bid to a firm you do not think has the proper organization—and that is not meant in any way detrimental to their organization—because if you do give them a chance to bid and they are the low bidders, then they are entitled to it. The time to draw the restriction is before you give out the specifications. In my experience in awarding a lot of jobs, both on main contracts and on subcontracts, in the construction at Philadelphia, it frequently has happened that a firm that has not the qualifications both as regards the personnel and as regards equipment has been given an opportunity to bid on some government work and has proven itself the lowest bidder. Then you have got to give them the contract and it has created all sorts of trouble to try to make them live up to it. We consider that a job of importance should be negotiated with only responsible people, and I mean by that responsible in every way—not simply financially responsible or morally responsible, but taking into consideration their organization, personnel and equipment."

Qualifications of Ship Repair Companies

When President Philip A. S. Franklin, of the International Mercantile Marine Company, was in Washington, he was asked whether, incident to activities of his company in the role of agent for the United States Shipping Board, any standard of qualifications was fixed which must be met if shipbuilding yards or repair plants were to have an opportunity to figure on repair and reconditioning work of magnitude. His reply was: "No detailed standard was agreed upon. We had our knowledge of exactly what the situation was at the various plants, or an idea of the capacity and the ability of the various yards of the country. We considered their financial responsibility and the matter of technical staff was very much in our minds."

It turned out that one firm with a yard in the vicinity of New York felt aggrieved that it was not given an opportunity to bid on the *Leviathan*. President Franklin, when asked about this, replied: "My impression is that they are not sufficiently staffed and equipped to do a job of this kind. They are very good people. I am not casting the slightest reflection upon them. If we had ordinary repairs to be made, we would be very glad to consider them." W. F. Gibbs, chief of construction of the International Mercantile Marine, was asked also why one yard that aspired to undertake the biggest of repair jobs was not given an opportunity to figure on the contract, and he replied: "I did not feel that their experience was such as to justify their taking work of this magnitude."

An angle of the repair proposition as it is now presented in the United States which may have more or less significance for private interests is found in an inclination on the part of the Government to utilize the enlarged facilities of United States navy yards for repair work on merchant vessels, and, coincident with this trend, a disposition on the part of the executives and agents of the Shipping Board to give preference to the navy yards in contracting for repair work. Director of Construction and Repairs Hague is on record with regard to the reconditioning of the *Leviathan*: "Personally, I would rather see the job done at a navy yard than at a commercial yard. We get better workmanship." President Franklin, of the International Mercantile Marine, has also declared for execution at navy yards of repair work on government ships, particularly if there enters in the question of keeping occupied a navy yard force.

Standardization of Structural Shapes

Recommendations of Sectional Committee on Steel Shapes for Adoption of Anglo-American Standard Beam Sections

On the entrance of the United States into the war with the Central Powers there came a demand for immediate increase in ship construction which, in turn, meant increased production by the steel mills. To increase production to the maximum and to simplify order practice, a conference of steel makers was held in Washington on July 2, 1917, at which was adopted American standard practice for structural steel for ships.

The result of this action proved distinctly beneficial both to the mills and the shipyards, but was not followed immediately by a standardization of and a reduction in the number of structural shapes used at the yards, and in consequence the Emergency Fleet Corporation undertook an investigation to ascertain definitely the number of structural shapes used in shipbuilding and the possibility of their standardization and reduction in number. As an outcome of these investigations carried on by Fred T. Llewellyn in the Division of Steel Ship Construction under Daniel H. Cox, manager, it became possible to determine what were the sections in most general use and at the same time were brought out clearly the divergences in the sections rolled by different mills.

Adoption of British Standard Sections

At a conference of steel makers held in Philadelphia on November 19, 1918, inasmuch as the British standard sections of ship channels and shipbuilding bulb angles appeared to be better adapted to economical manufacture than the American standard sections, and inasmuch, further, as the new rolls which had been turned in recent years to produce such sections conformed in general to British standards, it was decided that thereafter American standard sections should be discontinued and that rolls not then to British standards be redressed at as early a date as possible to roll such sections as closely as possible to British standards, and this particularly in view of the further fact that the adoption of British standard sections would enable American mills to compete on an even basis for ship steel wherever utilized in shipyards, either at home or overseas.

Revision of British Standard Sections

The British standard sections thus adopted as American standards were those adopted by the British Engineering Standards Association as published in 1903, and it was

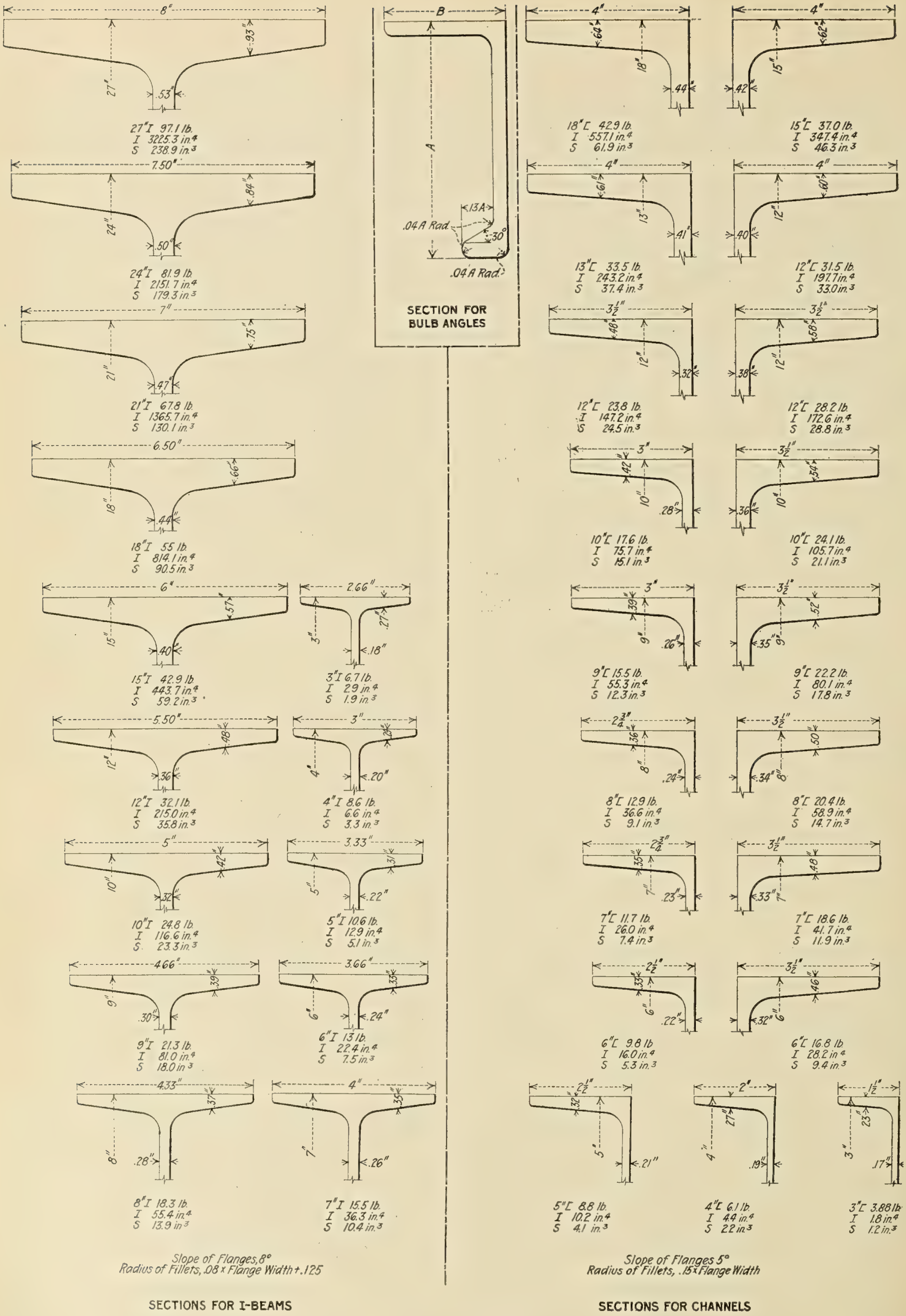


Fig. 1.—Bulb Angle, Channel and I-Beam Sections Recommended for Adoption as Standards

not known that this association had undertaken a revision of the British standard sections in 1913, work on which, however, had been suspended by reason of the war activities. When, however, through the trade press information as to what had been done in the United States came to the attention of the British Engineering Standards Association, that association advised American steel makers as to the situation, and later through their secretary, Mr. LeMaistre, expressed their desire to have the American structural trade co-operate with the British Engineering Standards Association in the formulation of common Anglo-American standards for structural shapes.

Organization of Sectional Committee

At the instance of the Association of American Steel Manufacturers, a sectional committee on steel shapes was organized under the auspices of the American Engineering Standards Committee. This sectional committee is composed as follows:

American Bureau of Shipping
Captain C. A. McAllister
David Arnott
John Martin

American Society of Civil Engineers
J. H. Edwards
J. B. French
H. G. Balcolm

Association of American Steel Manufacturers
R. B. Woodworth (chairman)
G. H. Blakeley
Geo. E. Thackray

Railway Car Manufacturers' Association
A. E. Ostrander

Society of Naval Architects and Marine Engineers
Fred T. Llewellyn
E. H. Rigg
J. W. Stewart

United States Navy
Commander C. M. Simmers
Lieut. Com. H. D. Rouzer

Recommendations of Sectional Committee

The sectional committee gave a very careful consideration to the entire routine of structural practice in the United States not only as it affects the profiles of structural shapes themselves, but also as regards methods of order, practice, calculation and publication of weights, areas and properties, etc., with the idea to insure as far as possible a complete accord between makers and users wherever the sections rolled in English-speaking lands were used. At its meeting held on April 27, 1920, it formulated its recommendations for submission to its sponsor organizations, to the American Engineering Standards Committee and to the British Engineering Standards Association as a basis for common Anglo-American standards, and its conclusions are now to go before these organizations for further discussion and endorsement. The essential features of these recommendations are:

(1) The adoption of the decimal system for the expression of dimensions, thicknesses and other elements of order practice.

(2) The adoption as an Anglo-American standard of the standard order practice adopted by the Association of American Steel Manufacturers on February 20, 1920, under which structural shapes are to be ordered by weights per foot and not by thickness.

(3) The adoption as an Anglo-American standard of American standard practice as it relates to ranges of thicknesses, methods of computation and methods of publication.

(4) The adoption of definite ranges in thicknesses of angles and other structural shapes, under which are established two zones of variations between minimum and maximum thicknesses. Under .60 inch thick variations are fixed at four one-hundredths (0.04) inch, and above .60 inch thick at eight one-hundredths (0.08) inch.

(5) Included in the list of angles is an equal angle (9 by 9) and four unequal angles (8 by 4, 9 by 4, 9 by 6 and 10 by 4), which are not now rolled in the United States but are subject to the considerations which weigh with manufacturers when new rolls are contemplated.

(6) The adoption of a new line of bulb angle sections as proposed by the British Engineering Standards Association that are recommended on account of their greater efficiency as compared with present British and American standards.

(7) The adoption of a single line of channel sections with a 5-degree flange taper to displace the present two American lines, the structural line with its flange taper 9 degrees 27 minutes 42 seconds and the shipbuilding line with its flange taper of 2 degrees. This line of channel sections is not quite in accord with that proposed by the British Engineering Standards Association, but is believed to be more suitable to the requirements of the American trade and better proportioned.

(8) The adoption of a new line of beam sections to take the place of the present American standards adopted in 1896. These sections have wider flanges than present American standards and do not agree very closely with the British proposals, but are believed by the Sectional Committee to be more nearly in accord with the recent developments in the fabrication of buildings and bridges.

Fig. 1 shows the new lines of bulb angle, channel and I-beam sections recommended for adoption as standard.

Motorship Cubore

THE motorship *Cubore,* of 11,500 tons deadweight, built and engined by the Bethlehem Shipbuilding Corporation, Ltd., is propelled by a two-cycle Diesel oil engine of 3,200 horsepower, designed by Arthur West, consulting engineer of the builders. After successful trials the vessel has just gone into service, carrying ore from the Bethlehem Steel Corporation's Cuban properties to the Bethlehem plants in the United States.

This ship represents an important advance in marine engineering in the United States, as its heavy oil Diesel engine, designed by an American and built by Americans for use in an American ship, represents this country's first successful attempt in a field that thitherto has been held exclusively by foreign interests. The *Cubore* has a length over all of 469 feet, a length between perpendiculars of 450 feet, a molded beam of 57 feet and a depth molded to the upper deck of 37 feet. The deadweight carrying capacity is about 11,500 tons. At normal speed the main engine turns over at 105 revolutions per minute.

In addition to the Diesel propelling machinery, an oil-fired Scotch boiler with 1,800 square feet of heating surface has been installed, designed to carry a working steam pressure of 140 pounds per square inch for auxiliary purposes.

Launch of S. S. Boswell.—Messrs. Harland & Wolff, Ltd., recently launched from their yard at Belfast the steamship *Boswell,* a standard cargo ship of the "B" type, building to the order of Messrs. Lamport & Holt, Limited, Liverpool. The length of the vessel is 413 feet 4 inches, the beam 52 feet and the gross tonnage 5,200. Propulsion is by double reduction geared turbines capable of developing 2,300 shaft horsepower.

Forced Lubrication for Marine Engines

Application of Forced Lubrication to Reciprocating Engines—Arrangement for Oiling Main Bearings, Crank Pins and Crossheads

BY LIEUTENANT-COMMANDER W. C. OWEN, U. S. NAVY

MUCH time and thought have been given to the question of the development of a satisfactory and reliable forced lubricating system for marine turbine installations aboard vessels of all types. Today we can safely say that we can see the results of the labor that has been expended on this subject, as shown by the more satisfactory operation of these installations and the small repair bills caused by accidents attributed to the failure of the lubricating system. Turbine installations are now fitted with safety devices to take care of the lubrication in case of breakdown of the lubrication system, with warning signals, both visual and sound, to warn the operator in case the system is not operating properly or any bearing is not receiving sufficient oil.

While the above has been going on in the turbine installations, the lubrication on the reciprocating engines of the merchant marine has been practically at a standstill, and we are using the same methods we have used for generations—namely, hand lubrication and sight and wick feed lubrication, except in very few instances when forced lubrication has been installed.

Forced lubrication of engines is not a new idea. It has been successfully used for years in dynamo and blower engines of high rotary speed. About 1906 the British Navy applied this system to its large reciprocating engine vessels, and about 1909 the United States Navy installed it on all battleships then building and authorized it for many of the battleships already built, and for all armored cruisers. These installations have met the expectations of their designers and have proved the wisdom of their judgment, as shown by the improvements noted below:

Increased Reliability—Decreased Friction—Economy of Oil—Reduced Repair Bills

The reliability of the vessel is increased due to the fact that all bearings at all times are supplied with sufficient oil and are not burnt out, delaying the vessel through having to renew or adjust them.

Friction is decreased due to sufficient oil always being supplied to all bearing surfaces.

The oil used is recovered and used over again and again, and there is no loss except through leakage, which can be avoided by careful watching of the system and which can thereby be reduced to an inappreciable amount compared with the hand or sight and wick feed. In this connection I might mention the fact that a forced lubrication system requires a straight mineral lubricating oil instead of a compound lubricating oil as is used in the sight and wick feed. The price of the straight mineral oil is considerably less than that of compound oil and, furthermore, less oil is used, thereby making the savings from oil bills considerably more than would at first appear.

The cost of repairs for renewal of bearings is reduced to a minimum. The writer recently served on a vessel equipped with reciprocating engines fitted with forced lubrication, and during his time of a year and a half on that vessel it was not necessary to renew a single main engine bearing, although the vessel cruised approximately eighty thousand miles during that time. The engine remained in perfect alinement and no work outside of that done by the ship's force was performed on the engines during that time. At the end of that period the engines were in as good condition as at the beginning, if not better.

Fig. 1 shows the usual arrangement for the oiling of the main bearings, eccentrics, crank pin bearings, crosshead pins and guides.

Description of a Typical Installation

As shown in Fig. 1, oil is supplied under a pressure of from 25 to 30 pounds per square inch gage to the main bearings, crank pin bearings, crosshead pins, crosshead

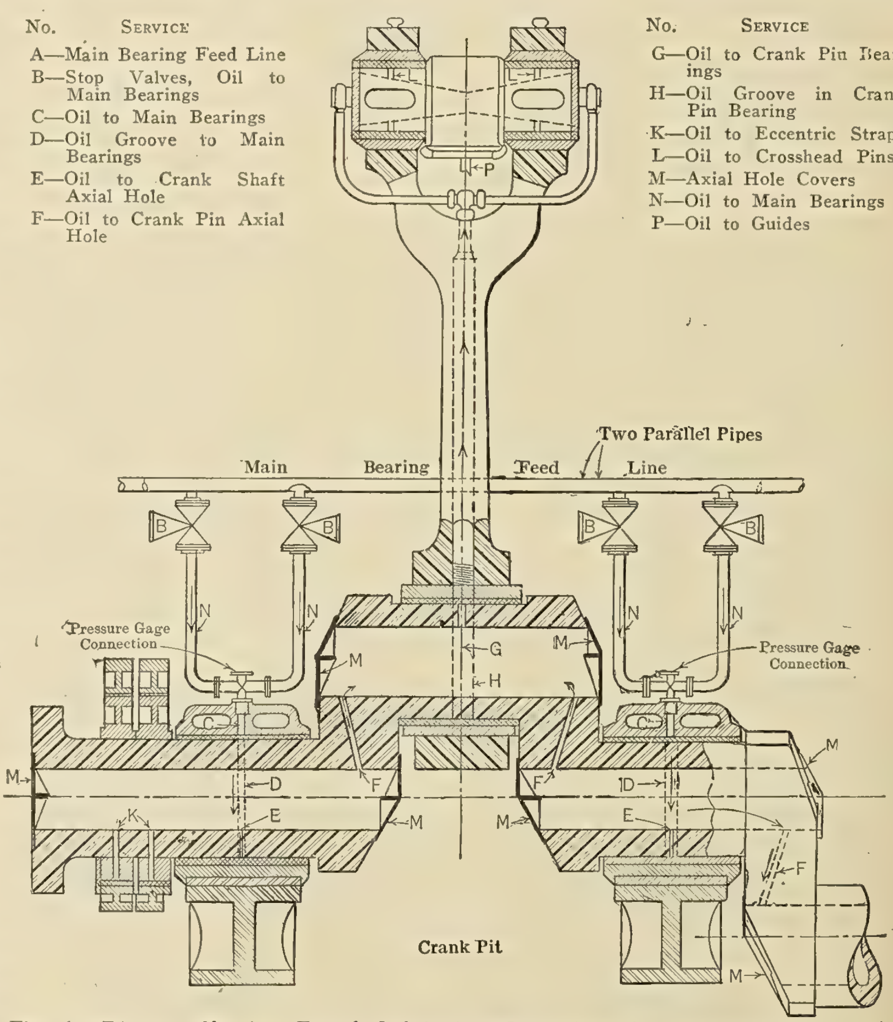


Fig. 1.—Diagram Showing Forced Lubrication Connections for Connecting Rod and Crankshaft of Main Engine

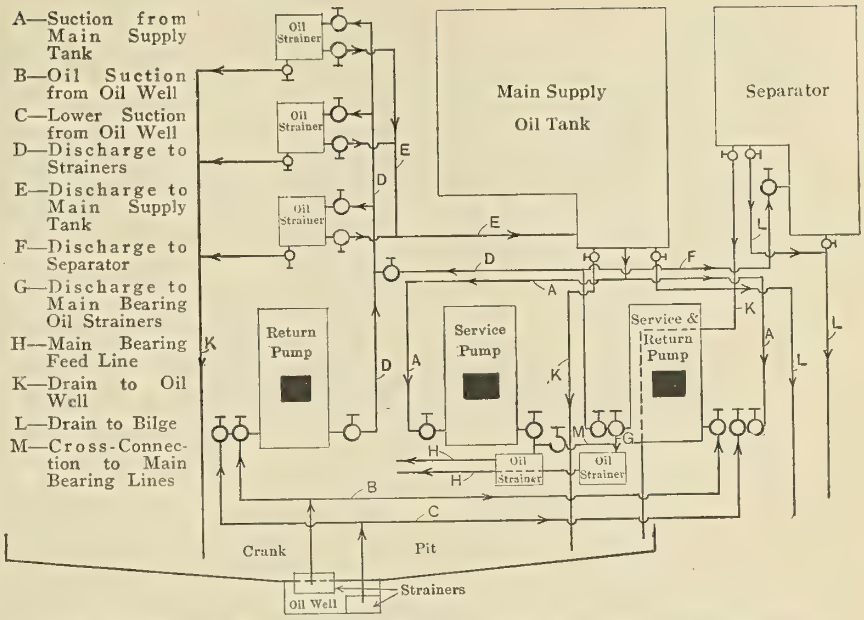


Fig. 2.—Diagram Showing Piping Connections of Forced Lubrication System

guides and eccentrics. At each main bearing a radial hole is drilled through the crank shaft to the axial hole in the shaft. In the path of the hole in the shaft an annular recess is cut in the main bearing brasses. For oiling the eccentrics a radial hole is drilled in the shaft and an annular recess is cut in the eccentric brasses. The oil is forced out of the side of the eccentrics. The axial hole in the crank shaft is connected to the axial hole in the crank pin by drilling a radial hole in the crank web. Radial holes are drilled in each crank pin to the axial holes in the pin, and in the path of the hole in the crank pin an annular groove is cut in the crank pin bearings. The axial hole in the connecting rod is extended through the crank pin brass to the crank pin. The above forms a closed circuit for the oil from the main bearing supply pipe to the top of the connecting rod. Oil is taken from the connecting rod axial hole by piping to the axial hole in the crosshead pins.

Oil-tight cups are fitted at the ends of the axial holes in the crank shaft, crank pins and crosshead pins. A gage and thermometer are fitted on each main bearing.

Referring to Fig. 2, which is a diagrammatic sketch of a typical layout in the engine room, there are located a forced lubrication service pump, a service and return pump and a return pump; a supply oil tank, fitted with cooling coils and oil separator; three strainers, for the supply oil tank; two strainers, for discharge to the engines, and one oil well strainer. Oil is supplied to the bearings by either the service pump or the service and return pump, and passes through strainers, either pump being able to use either strainer or either discharge line. At each main bearing two valves are fitted, one for each oil feed line for the purpose of regulating the flow of oil.

The oil is forced out on the inside of the crosshead pins and falls into a trough carried on the crosshead, whence it is fed to the guides by two pipes. The guides are also lubricated by pipes leading direct from the main supply pipes.

Course of Oil Through the System

The course of the oil through the system is as follows: The service or the service and return pump takes the oil from the supply tank and discharges through a strainer to the engine supply pipes. From the main supply pipes branches take the oil to the main bearings through holes in the bearing caps, to the guides and the manifold, which supplies the link pins, and to the thrust blocks. The annular grooves in the main bearings distribute the oil through the bearings and into the crank shaft axial hole through the radial holes in the journals. The crank pins receive their oil through the radial hole in the crank web connecting the axial hole in the shaft and the axial hole in the crank pin and the radial hole in the crank pin. The eccentrics are lubricated through radial holes drilled in the shaft and eccentrics. The crosshead pins are oiled through pipes leading from the axial holes in the connecting rod to the axial hole in crosshead pins and out through radial holes.

The thrust bearings are supplied by pipes from the main supply lines to which valves are fitted to regulate the flow. After lubricating the bearings, the oil is forced out of the ends of the bearings and drains to the crank pit, which serves as a well for catching the oil. The crank pits are of an oil-tight construction and are fitted with an oil well so constructed that no bilge water or dirt can enter and mix with the oil.

To prevent splashing, the engine is entirely encased with a thin sheet metal casing up to within about twelve inches of the bottom of the cylinders. Doors and sight holes in the casing are provided for observing the operation of the engine.

Branches are led from the main supply pipes to present sight and wick feed manifolds, which feed the link blocks through pipes, as at present.

From the crank pit oil well the oil is returned by the return pump to the supply tank.

The separator provides a means for separating the oil from the water or other foreign matter that may become mixed with it. After being cleaned, the oil is returned to the system through the crank pits.

On those cylinders in which a vacuum is carried it is necessary to fit the piston rod with some form of steam seal to prevent the oil being sucked into the engine and carried over to the boilers in the feed water. Several types of steam seals are now on the market which give satisfactory results.

Alternate Arrangement

An arrangement somewhat better than the above could be made on those vessels having a large engine room hatch, in which the supply tank could be placed at a sufficient height to give the oil a pressure of about 20 pounds per square inch and have the oil fed to the system by gravity.

In this case only two pumps would be required and it would be best to have both connected up as service and return pumps. Normally either pump would pump the oil from the crank pits to the supply tank, whence it would be fed by gravity to the system, or in case of necessity the oil could be taken directly from the crank pits and forced through the system.

Care to Be Taken in Use of System

In using this system, care must be taken to use a pure mineral oil, one that does not saponify and leave a gummy residue. An oil that would saponify, when brought in contact with water (which will be present from small steam leakage along piston and valve rods) and the churn-

ing movement of the cranks, would cause a lather to form which in time might become too thick to be forced through the pipes and oil-ways. The strainers provided will guard against any dirt or mechanical impurities that might be in the oil, but they do not prevent saponification.

Special oils are provided for forced lubrication and are supplied by all the leading oil companies. No trouble is experienced in obtaining a satisfactory oil. It is not necessary to limit the system to any special brand of oil, as the oils can be mixed with just as good results as obtained by using only one brand of oil, but in no case should a compound or marine engine oil be mixed with a forced lubrication oil. When a vessel is fitted with forced lubrication it is best to have only one kind of oil aboard, that for the forced lubrication system (except special oils such as cylinder oil, ice machine oil, etc.) as this has been used on the auxiliaries with just as good results as from the compound oils.

Motorship Building in Europe

BY OUR SPECIAL LONDON CORRESPONDENT

PROBABLY nothing has excited more interest in Diesel engine circles than the problem of construction of double acting, two cycle engines. The majority of English engineers consider that the double acting type of motor is too complicated to warrant its adoption, but, on the other hand, it is recognized that when it comes to powers of 12,000 horsepower needed for transatlantic liners it is a somewhat difficult matter to meet the necessary conditions in adopting the single acting principle.

Before the war German firms had experimented very extensively with double acting engines, and both at Krupps and at the M. A. N. works three cylinder sets of 6,000 horsepower were built. The engine constructed by the latter concern unfortunately met with a bad accident, which gave a setback to the double acting type. Nevertheless, Blohm and Voss, the well-known shipbuilders of Hamburg, who were connected with the M. A. N. concern, built a motorship in which they installed two double acting Diesel engines. This vessel, named the *Fritz,* was only completed just at the outbreak of war and was therefore never put into commission. Recently she was handed over by the Germans with a large number of other vessels to the British Government and she has lately been put into commission, being run by the Glen Line, which is already well known as owner of a large number of motorships.

Fig. 1.—Motorship *Fritz*, the Only Vessel Fitted With Double Acting Oil Engines

It is interesting to record, therefore, that in the two or three months during which she has been trading between British and Continental ports, complete success appears to have been obtained with the machinery and the engineers speak very favorably of its operation. The motors are on the small side comprising a couple of 850 brake horsepower sets, but if it is proved that the principle is satisfactory it is not unlikely that some important developments will take place in the construction of larger engines of the same design.

It cannot be said, however, that the engines of the *Fritz* show much advantage over the two or four cycle, single acting motors, since they weigh approximately as much, while the fuel consumption is considerably higher. Moreover, they are extremely complicated, as valves are used for scavenging instead of ports. Naturally, there have to be two fuel valves at the bottom of the cylinder in order to get an equal distribution of fuel, owing to the position of the piston rod, which passes through a specially designed water cooled stuffing box. There are thus three valves to operate in the top cover and four in the bottom cover (two scavenging and two fuel valves), rendering the employment of three camshafts necessary. These camshafts are arranged so that there are two at the bottom and one at the top, all deriving their motion from a common drive from the crankshaft. There are no mechanically operated valves in the cylinder head, since the air is distributed direct to the cylinder covers through air distributors arranged close to the control wheel. Air pipes are taken from these distributors to the cylinder covers in which are only non-return valves.

The engines have cylinder dimensions of 480 millimeters bore and 710 millimeters stroke and develop their full power of 850 brake horsepower at 120 revolutions per minute. There are three cylinders and the scavenging pumps and air compressors are arranged on the engines themselves, which are therefore wholly self-contained. Reversing is accomplished by turning the crankshaft relative to the camshaft through a small angle so as to cause the fuel valves and the scavenging valves to open at the correct position for running in the astern direction. The starting valves are also set to open at the right time according to the direction of rotation by means of a handwheel on the starting platform. The fuel consumption of the *Fritz,* which carries about 5,000 tons of cargo at a speed of 10½ knots, is about 7 tons per day, and the consumption per brake horsepower hour is approximately half a pound, which is some 25 percent above the ordinary four cycle design.

Many extraordinarily interesting developments are now being made in motorship construction, but perhaps none is more important than the building of four large passenger

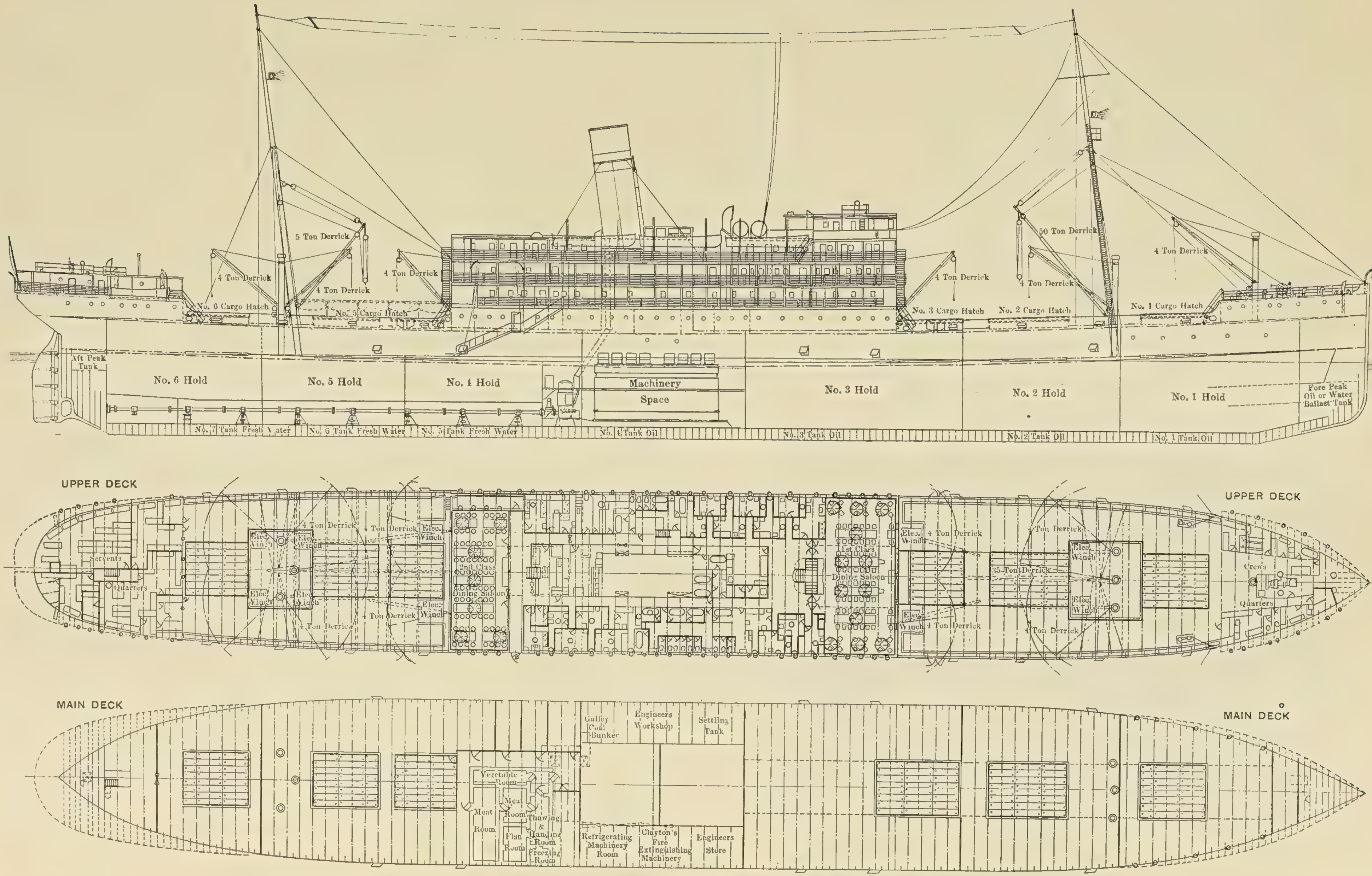


Fig. 2.—General Plans of 13-Knot Motor Passenger Liner *Magvana*, Building for the British India Steam Navigation Company

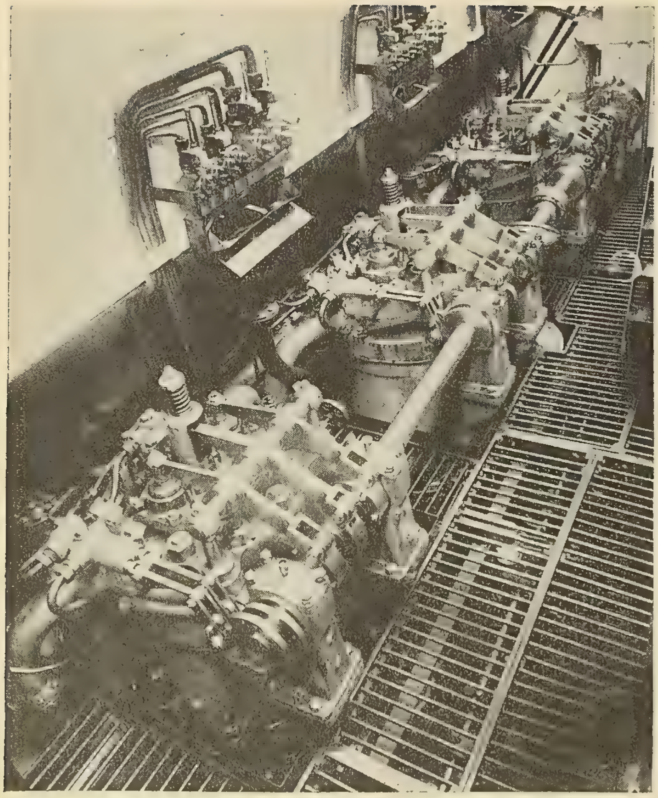


Fig. 3.—Top View of One of the Double Acting Diesel Engines in the Motorship *Fritz*. In Each Top Cylinder Cover Are Two Scavenging and One Fuel Valve

liners for the British India Steam Navigation Company, all of which are now under construction on the Clyde. The first, named the *Magvana*, will be ready for service in the course of two or three months and will be put on the regular British India route between London and India. She is designed to carry about 150 passengers, besides 10,000 tons of cargo, and is a standard class of ship, which hitherto has been built only as a steamer. The engines will also be a departure from ordinary practice, for, while in three of the ships an entirely new design will be used, in the fourth Sulzer two cycle engines are to be fitted.

All the new ships are to be equipped with machinery of between 4,000 and 5,000 horsepower. The engines in the first three ships will be of four cycle type constructed by the North British Diesel Engine Works, two motors being fitted in each vessel. These units will develop 2,300 horsepower each and have eight cylinders 26½ inches diameter and 47 inches stroke, and will be remarkable from the fact that at any rate in the first vessel the air compressors for injection and starting air will not be fitted on the propelling engines, but will be driven separately by Diesel engines.

It is now becoming customary on the majority of European motor vessels to use electrical machinery instead of a steam plant, and this is adopted on the passenger liners, two 400-horsepower oil engines being installed, driving two 40-kilowatt dynamos for the supply of power to the winches and steering gear and for lighting, etc. All the other passenger carrying shipowning companies are greatly interested in this new development, and it is believed that should the new craft be completely successful there will be a very large number of orders placed for similar or larger ships.

Scandinavian shipowners are finding it quite impossible to obtain all the motorships they require from the shipbuilding firms in Norway, Sweden and Denmark, and British shipbuilders are benefiting in consequence. One Clyde yard alone (the Ardrossan Dry Dock and Shipbuilding Company) has five motorships on order, two for Norwegian and three for Danish owners. The first two are 7,000-ton craft, 390 feet in length, fitted with a couple of Werkspoor engines built in England by Hawthorn Leslie and Company, developing a total of 2,500 indicated horsepower. Two of the remaining three are to carry 9,000 tons and will be fitted with Burmeister and Wain machinery, while the fifth vessel is to carry 8,500 tons and will also be equipped with engines built by Burmeister and Wain.

There is absolutely no question that were there more engineering firms in Great Britain in a position to take on orders for the construction of marine oil engines, far more contracts for motorships would be fixed in spite of the fact that there is a distinct slump in shipbuilding and many orders for steamers have been cancelled. The reason is that shipowners are now realizing that for the majority of trading routes the oil-engined vessel will show to the greatest advantage when it comes to the question of cutting freights.

Destroyer Satterlee Breaks Speed Records

All American speed records were broken by the destroyer *Satterlee* when she made a mile at the rate of 38.257 knots and averaged 37.272 knots in her five top-speed runs in her standardization trials held off Rockland, Maine, on June 8. The best previous record is 37.04 knots, held by the destroyers *Dent* and *Wickes*.

The *Satterlee* was built by the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., and is one of the latest class of United States 1,200-ton destroyers. Her engines consist of two Westinghouse 14,000-horsepower turbines, each of which drives a propeller through a floating frame gear that reduces the rated turbine speed of 3,050 revolutions per minute to 452 revolutions per minute for the propeller. The power actually developed by the *Satterlee* was, however, 31,223 horsepower, which forms another record for this class of vessel. The maximum speed of her propellers was 486.04.

Each of her turbines consists of two elements—high pressure and low pressure—which drive the propeller through a single 2-pinion gear. Either element can be used independently of the other in an emergency, so that if one element should be out of commission the vessel can still proceed, though at reduced speed. An astern turbine, giving 25 percent ahead power, is incorporated within each turbine element.

The fuel economy of the *Satterlee* is also exceptionally good, being below one pound of fuel oil per shaft-horsepower hour.

Japan's Naval Programme.—The Japanese government has decided to ask for an appropriation of approximately $22,199,499, to be expended in the construction of new warships and other naval requirements for the current fiscal year as part of the national defense. The programme includes the construction of four battleships, four battle cruisers, twelve cruisers, thirty-seven destroyers and a number of other craft. The whole programme is to be completed by the end of 1927, the total expenditure being fixed at over $450,000,000, spread over ten consecutive years.

Review of Problems Involved in the Production of Motorship Machinery

BY HUBERT C. VERHEY

The attention of the individual and maritime world is now centered upon the question of fuel conservation and general economies more than ever before, owing to either the lack of supply or production of liquid fuel and coal. This situation has once more brought the application of internal combustion motors into the limelight, as no doubt the use of liquid fuel burned under boilers is a comparative waste, a fact which is readily explained when we consider that the actual utilized heat units are approximately three times greater when the fuel is applied direct to the prime mover, as is the case in oil motors.

THE production of heavy oil marine motors, and only such will be described in this article, is practically a new field. It has not been a walkover from the start, which probably counts for much of the undue criticism extended. It has been demonstrated that the introduction of such machinery had to battle with a great number of handicaps, which have been gradually but slowly overcome. When all the facts are generally known and understood it may result in undivided appreciation of the splendid engineering work performed by manufacturers and shipbuilders who cast their lot with this new industry which is conducted along so different lines from steam power practice.

Today cargo carriers equipped with reliable machinery can be seen in overseas service, although in small numbers; hence it may be of interest to follow the general development by mentioning some of the troublesome features encountered. The writer has no intention to make claims that the last word has been spoken notwithstanding the great strides which have lately been made the world over, even during the war.

The Most Modern and Economical Machinery

The subject is very timely, particularly in view of the fact that Congress has authorized the United States Shipping Board to support the development of the most modern and economical machinery equipment for ships to be built in the future by private parties; the only means that will put America in a position to compete on the seven seas and uphold her merchant marine.

Approximately ten years ago internal combustion motors of the Diesel type were first used for the propulsion of sea-going vessels, and they were introduced by European builders. It is interesting to note that the smaller nations were the pioneers in the field as respectively the Hollanders, Scandinavians and Belgians developed marine installations the very moment enough experience was obtained by building stationary motors under German license.

The reason for this may be explained by the fact that all except the Belgians suffered from a lack of coal supply from their own lands and as seafaring nations would benefit by the use of vessels having great cruising radius.

German Development of Stationary Oil Motors

An enormous business developed in the stationary field in Germany was probably the reason that German concerns made comparatively less effort to produce marine motors, as all manufacturers of small as well as large units were prosperous, and apparently rocked themselves to sleep at that time. In fact, the first large crosshead type engines were originated outside of the mother country of the Diesel motor. The grade of perfection to which stationary motors were developed in Germany cannot be denied, but as it goes in engineering, certain principles successfully applied under given conditions are not always suitable to other fields, which has been plainly demonstrated by the failures of certain designs of marine motors.

Early Difficulties

It is reasonable to assume that the preliminary trouble encountered in the manufacture of marine Diesel motors was the fact that the builders did not have a sufficient all-around knowledge of oil motors to combine their previous experience with the essentials for reliability, handling facilities and endurance of such machinery in a ship, but lots of credit is due them for their endeavors to face this costly period of development at their own risk and expense, as it was not a case where the possibility of falling back upon the experience of the originators of the Diesel motor was available. In one instance I know it to be a fact that objection was raised by the license holder to adopt crossheads for marine Diesel motors instead of the trunk type piston then applied. In the early stage of the game licensees virtually kept in close touch with the licensors in order to reduce risks, so that a great deal of credit is due to the progress of builders of the first sea-going motorships.

Similarity to Steam Practice

Analyzing the development, it is of interest to note the efforts of such builders to copy established steam engine practice as much as possible. It really was made a great talking point, and considered a necessity at the time to follow these lines very closely, as it was said to be impossible to operate a motorship successfully unless the personnel could handle machinery which was not very much different from the steam engine practice to which sea-going engineers were accustomed.

This, for instance, is one reason among others for the comparatively slow development and adoption of marine Diesel motors, as it has since been demonstrated that straight reciprocating steam engine practice cannot be followed to the best advantage and the failures that were a result of the early conception have invited undue criticism to the general principles of this highly economical prime mover.

Following the idea that a marine engine should be entirely open—in other words, that all main moving parts should be observed at all times and, if necessary, be touched by the operating engineer—has done its share towards the failures experienced with the early motors. It has been proven that the lubrication by gravity of these parts gave trouble, and it is remarkable to see that manu-

facturers who from the start adopted the entirely enclosed type, having a forced feed lubricating system, enjoyed better success, which has built up their present reputation.

Owing to the fact that Diesel motors are run with higher bearing pressures than the usual steam engine practice and, consequently, need a greater supply of lubricating oil, the entirely enclosed type of motor offers not only the advantage of a clean engine room, as no lubricating oil is thrown on the floor plates and no oil vapors enter the engine room space, contaminating the atmosphere, but also offers greater safety against overheating.

Forced Lubrication

When a forced feed system is applied, there is, as a rule, a main header running all along the motor, having branches to each main bearing. The oil enters the bearing caps, is conveyed by a groove around the journals, enters a hole in the journal, passes through the hollow journal, is discharged through a passage in the crankweb to a circular groove in the crankpin box and follows its way upwards through a hole in the connecting rod, whence it is distributed to the wristpins and guides. After the oil has done its work on the rubbing surfaces it is squeezed out at the bearing edges and drips down into the crankpit, where it is collected, carried to a sumptank, filtered and used over again.

Sometimes it becomes necessary to cool the oil, particularly when navigating in tropical waters, for which purpose an oil cooler is installed between the discharge end of the lubricating oil pumps and the main supply header.

The pressure carried on the system varies with the viscosity of the oil, but does not have to exceed 15 pounds. In order to be able to meet all conditions such as change in temperature of air and cooling water, the oil pumps should be of ample capacity and should be able to run at variable speed. The same holds good for the types of cooling water pump to be installed.

Temperature of the Sea

In order to be prepared to navigate on all seas, it is necessary to figure with the worst possible condition. For instance, around the Panama Canal the sea may have a temperature of 85 degrees F. (even higher temperatures are on record), and this very fact has caught some builders of marine motors in the early stage of the game. Although their ships might have been designed to run in certain predetermined trade routes, with auxiliaries adequate to meet given conditions, an unexpected change in route would show that insufficient preparations were made.

Conditions of this nature have materially influenced the reputation of motorships and were readily used by opponents, for mere business reasons, to criticize the reliability of motorships in general, the fairness of which I desire to leave to the reader's judgment.

Temperature of the Atmosphere

The changes of temperature of the atmosphere even during different times of the day have a marked effect on the proper functioning of a gravity feed lubricating oil system, as the actual discharge of oil is governed by its viscosity, the number of drops fed being reduced as soon as the cooling effect of the atmosphere makes itself felt. This will clearly show that the whole system depends on the care and interest taken by the operator, who is compelled to make adjustments in many places at different times. The argument is advanced by advocates of a gravity feed system that this is just one of the very good points of the system as a whole, as it tends to keep the operator from losing attention. This may be considered to be a mere statement to defend the particular constructional features of their products, principles of which were decided upon from the start and naturally must be adhered to for production reasons.

On the other hand, assuming that no practical fault can be found with a system which is constantly governed under pressure and which at all times can be controlled by the regulation of either the suction or discharge valve of the lubricating oil pump, while a gage which is properly located at the engineer's hand warns the operator of changes due to either the atmospheric or the cooling water temperatures, then there is no doubt as to the latter's superiority.

Partition Between Crank Case and Working Cylinder

The best designs of existing marine Diesel motors, particularly those of the single acting type, are provided with a partition between the crank cases and the working cylinders. This eliminates the mixing of lubricating oil with the foul gases that escape from the working cylinders past the pistons, when the latter need overhauling. I believe that I am justified in stating that special attention should be paid to features of this nature on board ship, where the working space is limited and the handling facilities are not to be compared with test conditions. In many instances designs have been criticised by the operators for just such reasons, which are not without foundation, although the argument may be advanced that the engines have to be built a trifle higher.

It is true that increased height requires greater rigidity for the foundation and the tanktop, but the object gained more than offsets this disadvantage, as it has given complete satisfaction in service. The lubricating oil consumption of engines of this construction can be held down to a minimum if the crank case doors, drip pans and pipe connections are tight, and it may be readily seen that the return oil is kept reasonably clean so that filtering is materially facilitated.

Crankshaft Troubles

Oiling systems, however, have not been the only troubles encountered with the Diesel motors. Crankshafts have broken at most inopportune times—not because the stresses were prohibitive on paper, as they had passed the inspection of the classification societies, which always have been very rigid, but in instances for faulty material or neglect and carelessness of operators, in other cases due to manufacturer's faults or poor design. Among the cases of bad design, it may be mentioned that frequently the designer kept only one point in view, namely, to keep the surface pressure down at all cost. He resorted to two things which we now know to be wrong, but which was not realized at the time. The first was to reduce all fillets to a minimum, the second to make very long journals, which means an increase of the bending moments in the center of the crankpin, as well as an increase in the distance between cylinders, incidentally producing a longer engine.

The approximate cylinder distances of the best of the large marine motors in the market is equal to about twice the cylinder bore. At this distance it has been proved that it is possible to construct a built-up shaft having crankwebs of sufficient width to insure safety, as progress has been made in the method of heat treatment of steel that has materially aided satisfactory production.

Comparing the early designs with those of the present, it is evident that an increase in width of the crankwebs has been made at the expense of the length of journals and to a certain extent of the crankpins, which is a great improvement, and that the forced feed lubricating system is a valuable medium to obtain the safety desired.

Crankshaft Proportions

With the design of a crankshaft and its proportions we are guided mainly by the experience gained in actual operation, as it is extremely hard and even impossible to determine by calculation all the factors that affect its strength and endurance; as so many different assumptions can be made. High grade steels are only used in cases of light-weight engines such as submarine engines. Much was thought of nickel steel at one time, but it did not prove to be a success, not even in steam engine practice, as the material eventually crystallized, causing the shaft to break without warning. Crankshafts built of chrome vanadium steel have been successfully used, this material having a tensile strength as high as 105,000 pounds per square inch. The material for slow speed engines is usually an open hearth steel of around 78,000 pounds per square inch tensile strength and of good ductility. Shrink or press fits as applied to built-up shafts vary with the shop practice of the manufacturers, but enough experience is available to insure successful production of crankshafts nowadays.

Cast Steel Crankshafts

Of late successful shafts have been built of cast steel. This material shows a wonderful polish after the motors have run for some time. Although the naked eye can detect tiny little black spots, showing that this material is not as close as a forging, it has been unmistakably shown that cast steel is a suitable material and that the very spots seem to be of help in holding the film of lubricating oil. The production of such castings is a matter of foundry skill, the proper application of risers and the annealing of the casting after the rough finish is taken off. As the production of Diesel motors is rather costly as compared with the reciprocating steam engines, the use of castings for the crankshafts will tend to cheapen their manufacture.

Motors with crankshafts having one-piece castings for two webs and a crankpin are now running successfully, and as these designs were accepted by the classification societies, further development may be expected in the near future. The use of cast steel for the crankshafts of large gas engines of 10,000 horsepower, having the crankarm and the overhung crankpin in one piece, has been a success from the start, and such engines have been successfully running day in and day out for some years in America.

Foundations

Foundations have also invited criticism, and weak designs have caused lots of trouble, which has not been beneficial to the reputation of heavy oil motors. In fact, that part of the ship on which the engine foundation rests must be exceptionally strong, particularly with single acting four cycle engines, as the comparatively sudden application of the working load causes forces to act which are not similar to those set up by the double acting reciprocating steam engine. Two cycle engines, even if single acting, work better on the shaft, as the turning moment is more even than that of the four cycle types.

I do not know of any case with large marine engines where bedplates have been particularly weak, but I have reason to believe that the troubles encountered with the pioneer engines of certain manufacturers were carefully watched by other builders, and that, for safety's sake, much unnecessary material was added to their products, which may explain the fact that successful engines are exceptionally heavy. It is only natural to anticipate that successful types are apt to be copied as far as patented features can be dodged, but this gentle act of copying is not of help to rapid development

Four versus Two Cycle Engines

Installations are of the four cycle type and are more numerous than two cycle installations, so that talking points raised in favor of four cycle installations can be more readily demonstrated, putting greater weight in the scale when a decision is pending as to what type of installation is most desirable on board ship. It cannot be denied that the construction of a two cycle motor requires more experience and skill than that of a four cycle motor for the simple reason that the heat problem is increased due to the time element. The actual working stroke occurs every four revolutions in the case of two cycle engines and every alternate revolution with four cycle engines, so that the temperature changes are more severe. This factor, in reality, is the most troublesome in internal combustion motor design and has made itself evident by the failures in early two cycle motors to a greater extent than with the early four cycle motors.

If, however, we study the development of details, it shows clearly that designers were not aware at the time of the weak points of their motors. In many cases very complicated and unsymmetrical castings were used. Symmetry should be made the first consideration and sudden and abrupt changes in metal thickness should be avoided. This knowledge has come to us at the extreme expense of those who underestimated these facts.

Operation of Cooling Installation

The proper operation of the cooling agent is a point of high importance, velocities should be equalized as far as possible and the supply should be unbroken even after the motors come to a standstill for either maneuvering purposes or after the finish of the run. It really looks absurd to mention it, but it is a matter of record that some early installations were not provided with auxiliary means of cooling water supply for cases as mentioned, which resulted in overheating of the cylinders and pistons and the consequent formation of cracks in these parts. This not only resulted in damage to the motors, but also provided a weapon in the hands of the opponents of heavy oil motors, who pointed, not without reason, to the poor reliability of same.

Local application of high temperatures is a hardship to any casting, and in this respect four cycle motors are worse off than two cycle motors, as their respective inlet and exhaust valves are usually located on the longitudinal centerline of the motors, and it may be readily seen that one side of the cylinder and liner is in a different condition under working conditions than the other, as the cool atmosphere inlet air enters on one side of the cylinder while the exhaust gases are rushing out to the atmosphere at the opposite side, which may explain the difference of heat conditions to which the material is subjected. It also affects the uniform circulation of the cooling agent.

An arrangement that is in use by some manufacturers provides, in cylinders of large dimensions, for two inlet and exhaust valves. This is a step in the right direction, although it does not do away with the fact that one side of the cylinder and liner gets more heat to absorb than the other, but this construction materially improves the symmetry of the casting, and incidentally makes it possible to use smaller valves which stand up better than larger ones and allow lower velocities of the gases, which also is an important point to keep in mind.

From the foregoing it may be readily understood that the cooling agent circulation is not uniform, and therefore special means of regulation have to be resorted to.

In this respect two cycle engines meet more favorable conditions whether they are designed for top scavenging

or for port scavenging. The so-called top scavenging system of two cycle motors is apparently the most rational, because as a rule a number of valves are located in the cylinder head and so distributed that the symmetry of the casting is maintained. Furthermore, the exhaust ports located at the lower end of the cylinder are distributed equally over the whole circumference, which not only affords an ample area for expansion of the exhaust gases but also renders it possible to utilize the expanding gases to the limit.

An Advantage of the Two Cycle Motor

In two cycle engines having port scavenging only, there are no scavenging valves in the head, which materially simplified that part of the motor, which is an appreciable factor. In this case the exhaust ports cover only half of the circumference of the lower end of the cylinders, as scavenging slots are provided in the other half of the circumference. A distinct advantage of two cycle over four cycle engines, comparing actual operating conditions with the use of extra heavy fuels, is this very port arrangement for the expulsion of the exhaust gases.

When the exhaust gases pass through an exhaust valve or valves in the cylinder head, they put a severe test on the valve seats, and with this method no means are provided for clearing away any solid matter that may remain after combustion. There should remain no doubt as to the superiority of this means of scavenging for two cycle engines, as it has actually been found that the two cycle engine is not liable to suffer from gummed pistons as soon as her four cycle rival, for which the remaining substantial matter in the combustion gases in cases when improper combustion occurs is directly responsible.

It is known that the exhaust valves of four cycle engines are the ones that need the utmost care, due to the extreme heat to which they are exposed. Breakage of their respective springs occurs the more readily, as these springs are also exposed to more heat than the inlet valves. For this reason certain manufacturers have resorted to means of reducing the heat effects on the exhaust valve by introducing a special port at the lower end of the cylinder, the opening of which is controlled by an automatic valve which opens by means of the pressure of the exhaust gases that prevail near the end of the working stroke. This relieves the main exhaust valve in the cylinder head from the initial severe heat conditions, thus prolonging the endurance, and as the port described has given no trouble whatsoever in actual service, it goes to show the merits of port scavenging.

Fuel Consumption

The question may be asked, why not go the whole distance in this case by building two cycle motors from the start? This question can be partly answered by considering the economics of both types, as it is known that the fuel consumption of four cycle is better than that of two cycle motors, the difference being from 4 to 10 percent, according to the various designs, in favor of four cycle motors.

Before dwelling further on the relative merits of four and two cycle engines, it can be mentioned that both types have suffered instances of bad designs. The details of the cooling water systems, and in some cases leakage of joints and stuffing boxes, have caused great damage, because lubricating oil containing an excess of salt water loses its faculty as a lubricant, and the emulsion thus formed, which gives the mixture a milky appearance, is entirely inadequate to safeguard overheating of the rubbing surfaces. Facts of this nature have done their share to create the sceptical stand taken against the rapid introduction of heavy oil motor installations, as the reputations thus gained proved to have a long-lasting nature, notwithstanding that precautions were immediately taken to avoid this unsatisfactory feature.

Compressors

Compressors of the early days had not reached the stage of development that we can refer to at present and gave more trouble than the actual working parts of heavy oil motors. This trouble has also been eliminated, proof of which is shown by the fact that installations have been kept in continuous operation considerably longer than a month. Compressors, as applied to Diesel motors on board ship, are oversized in respect to the actual necessary delivery capacity when the motors run at full power and rated revolutions.

By determining the output of the compressors, which thus far, as a rule, have been driven directly by the main motors, consideration had to be given the fact that with the engine running slow the time element for the lift of the fuel valve was prolonged accordingly. This naturally meant a loss of injection air, which could not be entirely divided with the present arrangement and therefore required larger compressors than strictly necessary under normal conditions. Furthermore, the requirements of Lloyd's classification society are "that in case of twin screw installations either one of the main compressors shall be of such capacity that both motors can be kept running at reduced speed." This, by itself, is very desirable, but it puts a hardship on the compressors proper, as they have to be made entirely out of proportion, which does not help the problem of cooling the compressed air throughout all stages; in fact, it is detrimental and only by the selection of the right materials for all parts involved, as well as the use of the proper lubricating oil, have these drawbacks been overcome and the increased heat problems nullified.

Drainage System for Air Compressors

It was also found to be very beneficial to arrange for a thorough drainage system, particularly for the low pressure stage, whereby the moisture contained in the atmospheric air drawn into that stage from the motor room space is prevented from following its way to the other stages, thereby insuring better working conditions for all valves and facilitating the problem of lubrication by reducing the carbon formation. When the points, as referred to, are given due attention, the compressor need not be a source of trouble.

The installation of independently driven compressors has been given serious consideration, although as far as the writer's knowledge goes independent driven units are not in actual service. This principle, however, appears to be sound, as it tends toward a reduction in the size of the compressors and should prove to be of help in running the main engines at lower revolutions. This is possible because the independent driven unit can be speeded up to take care of the increase in injection air consumption at lower than normal full power revolutions of the main motor or motors. This method also tends to better relative proportions of the various stages of the compressor, thus minimizing the work on the valves by facilitating the head problems involved.

Installations Without Air Compressors

Some concerns have eliminated the air compressor entirely, which not only saves about 10 percent of the horsepower which is needed for the so-called air injection fuel

distribution system but also does away with the consequent mechanical complication and has merits derived from simplification of the installation.

In this case the fuel oil is mechanically forced into the working cylinders under a high pressure and left to its own resources as far as the proper pulverization is concerned. It is called the solid fuel injection system. Claims made by manufacturers that have adopted this feature are very promising. Good fuel consumption is claimed, and, according to statements made, there is no difficulty in handling with good economy at all loads all kinds of oils, including those of the heavier grades.

The writer has had no opportunity personally to check these statements, owing to the fact that America has not built any heavy oil motors of this type thus far, and because she has not had the opportunity to see European-built motors working on this principle. The hope may be expressed, however, that the facts are as claimed.

It is true that no additional air is required in the combustion space formed when the working piston is in its upper dead center during the working stroke of either four or two cycle engines, as adequate oxygen is available in the compressed air proper. Claims have been advanced that the use of injection air improved the combustion, which does not seem to hold true throughout, as figures published by advocates of *solid injection* do not show poor economy, and their argument that the chilling effect of the entering high pressure air as applied to air injection type motors is not without foundation. The fact remains, however, that no all-around experience is available, and comparative data are lacking at present, as the majority of Diesel motor builders are using the air injection systems, while the solid injection system that is now claimed to be successfully applied is a patented feature.

Relative Merits of Four and Two Cycle Motors

Returning to the relative merits of four and two cycle motors, it is evident that much difference of opinion prevails. The ardent claims of four cycle advocates, particularly of those in the market with real successful motors, do not seem to carry the spirit of progress; in fact, it is my personal opinion that such claims are in some cases upheld for mere business reasons, as there can be no doubt of the actual advancement made by builders of two cycle motors, who, unfortunately, have not had such a share of the business in the early stage of the game, owing to the more difficult problems to be met in the production of two cycle motors, which in some cases have met with failure. The time has arrived when no one concerned can afford to resort to one-sided judgment, although the four cycle motor practically dominates the market at present and is able to produce wonderful records of reliability and endurance, much to the credit of the game in general.

In view of the present interest taken all over the world to promote and increase the production of heavy oil motors, which by their economy are bound to play an important part in meeting the fuel problem, it seems timely to advocate a stand of unrestricted and clear judgment as to the future course to follow, as conditions which created the demand and caused the actual development of heavy oil burning machinery across the water have greatly changed, and the greatest possible overall economy of our merchant vessels must be made our first thought.

At the time the smaller nations commenced their much appreciated development work, fuel oil especially of the medium grades was plentiful and cheap and the very heavy oils were sidetracked. There was, furthermore, no competition between motorships such as the near future will surely see, and there really was no comparison between the economies of the oil motor with its rival, the steam prime mover, on land or on the sea, the oil motor's only handicap being the more difficult design and production features seconded by the absence of sufficient experience.

Many attempts to produce reliable two cycle motors were futile, and the early lines followed were discarded for the mere reason that the way of least resistance, the four cycle principle, gave results almost from the beginning.

This policy has since been followed by the pioneers in the game, and their views were entirely justified and fortunately chosen at the time, so that the reputation of their products was thereby firmly established and holds good today.

Foreign Developments

In the meantime, Belgians, French, Italians and Swiss clung to their determination to develop the two cycle engine and have clearly demonstrated the possibilities. The world war was a great handicap to them and retarded further general development. Germany shortly before the war was also experimenting with two cycle motors, but did not accomplish as much in the marine line as the other nations mentioned. Her designs, particularly in the two cycle type of submarine engine, were duplicated under license by Americans and did not prove to be a success, so that their manufacture was finally given up. In the meantime, the Germans swung their efforts to the further development of four cycle engines with great suncess, as demonstrated by the quality of the motors driving the deadly submarines during the war. The Swiss in particular succeeded in developing their two cycle motors to a point that clearly showed that this type was not going to be counted out. Oil motors built along the general lines of construction as covered by Swiss patents were built under license in America. From actual touch with this building programme the writer may frankly state that work performed over here was a credit to the license holder and the American industry in general, as all material of the high class required for the construction of these motors, submarine heavy oil motors as they were, was produced in this country.

Today a great number of heavy oil motors of the two cycle type are performing extremely well in American submarines, and the usual troubles encountered with other designs have been eliminated. It was, therefore, clearly demonstrated that with proper design, distribution of material, etc., satisfactory results are obtainable.

These oil motors are all of the high speed types, in which the actual heat conditions which affect the lifetime of important castings are most severe, and for that reason confidence can be placed in the ability of American manufacturers.

England of late has made great strides in the development of marine oil motors and has even gone a step further by building two cycle engines of the opposed piston type.

June Shipbuilding Report.—The Bureau of Navigation, Department of Commerce, reports 194 sailing, steam, gas and unrigged vessels of 251,539 gross tons built in the United States and officially numbered during the month of June. About three-fifths of this tonnage are vessels owned by the United States Shipping Board. In addition to the above, four vessels aggregating 15,537 gross tons were completed in this country during the month of June for foreign owners. From other sources than construction, seven vessels of 13,260 gross tons were added to American registry during the month.

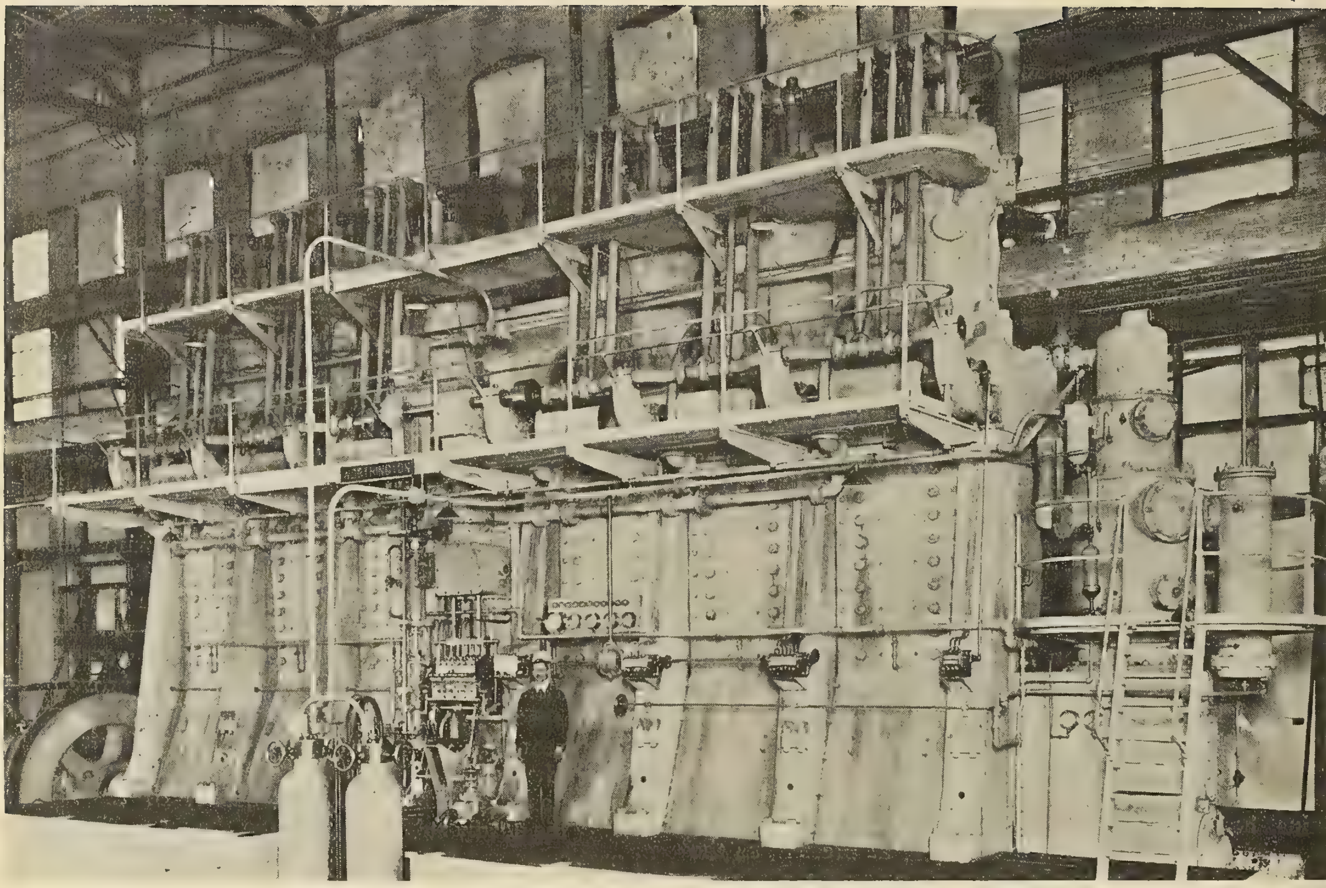


Fig. 1.—Quarter View of Worthington 2,400-Horsepower Diesel Engine from Compressor End

The Worthington Marine Diesel Oil Engine

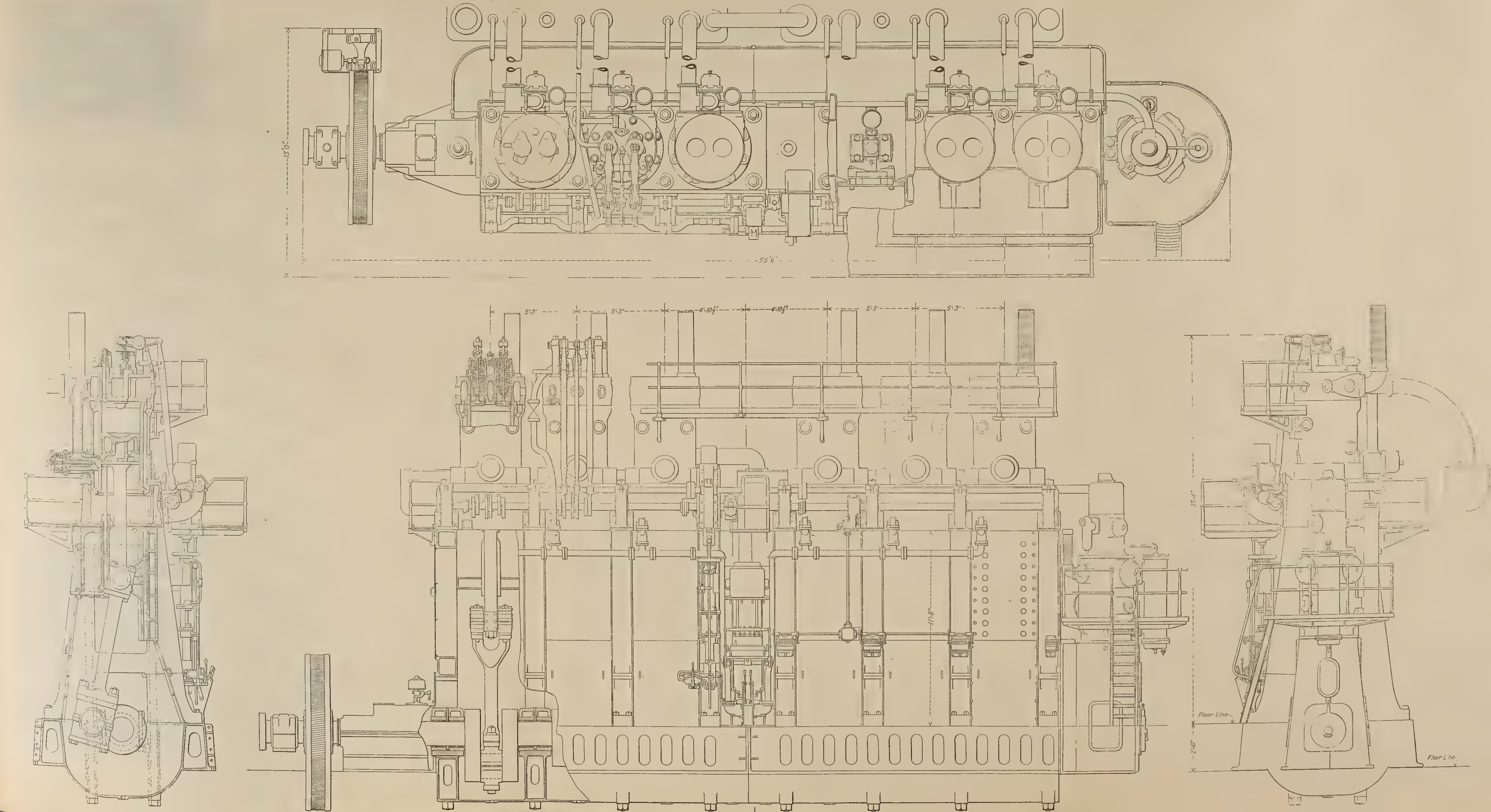
Convinced that the best cargo vessel to-day is the motorship, provided the motorship is as reliable as the steamship, the Worthington Pump & Machinery Corporation, 115 Broadway, New York, has entered the marine Diesel engine building field and is preparing to supply complete engine room equipment for deep-sea motorships. Backing up its faith by actual deeds, this company has built at its Snow-Holly Works, Buffalo, N. Y., where for years it has been successfully producing gas and Diesel oil engines of large power for land service, a six-cylinder, four-cycle reversible marine Diesel engine, capable of developing 2,400 indicated horsepower at 120 revolutions per minute. This is the largest four-cycle marine Diesel engine so far constructed in the United States.

WITH the gradual improvement of marine Diesel oil engines, chiefly in European countries, and with the rapidly increasing fleet of motorships now successfully operated throughout the world by foreign shipowners, American engine builders have come to the realization that in order for the American merchant marine to compete successfully for overseas commerce, motorships must be added to the fleet. Without waiting for the encouragement of a definite order for motorship machinery, the Worthington Pump & Machinery Corporation, New York, has developed under the direction of Mr. W. B. Jennings, chief engineer of its Snow-Holly engine building plant at Buffalo, N. Y., plans for an American type, four-cycle marine Diesel engine and has built its first large engine of this type which is now undergoing a month's non-stop run at the builder's shop.

The engine is of the vertical single acting, reversible, four cycle, "A" frame, crosshead, marine Diesel type with six cylinders, each 29 inches diameter by 46 inches stroke, arranged in a fore and aft line. Driven from an extension of the crankshaft at its forward end is a vertical three stage air compressor. At a speed of 120 revolutions per minute the engine develops 2,400 indicated horsepower, or 1,760 shaft horsepower. The total weight of the engine, including the compressor, flywheel, thrust bearing, platform, gratings, etc., is 339¼ tons, giving a weight per indicated horsepower of 327 pounds. Its length, including the compressor, is 45 feet, and with the flywheel and thrust block, 55 feet 6 inches, while the height from the center of the crankshaft to the top of the valve gear is 23 feet 10 inches.

The handling gear is mounted on the front, or inboard, side of the engine, between frames 3 and 4. The inlet valves, exhaust valves and spray valves are located in the tops of the cylinder heads and are operated by cams secured to a camshaft fitted in bearings in brackets secured to the side of the cylinder base plate. These cams transmit motion to the valve rocker arm by means of vertical push rods. The rocker arms are supported by standards on the cylinder heads. The camshaft is driven by a train

THE WORTHINGTON MARINE DIESEL OIL ENGINE



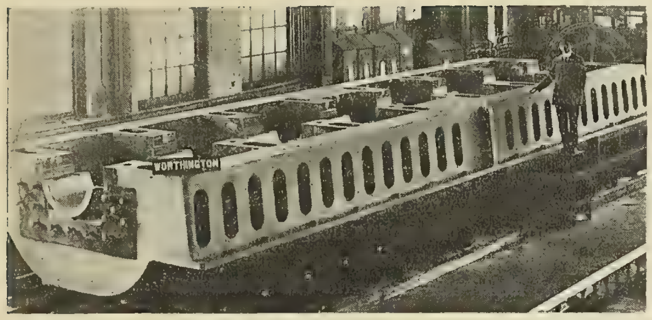


Fig. 3.—Bedplate. Weight, Each Half, 42,000 Pounds

of helical spur gears actuated from the main crankshaft.

The air starting valves are located directly under the camshaft, on the inboard side of cylinder base, with a pipe leading to each cylinder head. A spring loaded, non-return valve is placed in each line in the cylinder head.

The six fuel pumps, located in a block between columns 3 and 4, are driven by means of an eccentric on the upper gear spindle of the camshaft gear train.

Bedplate

The bedplate is of cast iron made in two sections, bolted together, each section supporting three cylinders. The longitudinal members on each side and the transverse members carrying the main bearings are of box section. The crank pit bottom is cast integral.

The main bearing seats are bored to receive the main bearing shells. There are eight main bearings, each having two semi-circular shells of cast iron lined with white metal and removable by rotating around the shaft. The main bearing cap is of cast iron and held down by four removable bolts. Cored openings are provided to decrease the weight in all places where the metal is not required for strength. The halves are secured by flanges and through bolts, alinement being secured by fitted bolts.

At the center of each crank pit is a hole for oil drain, all of the crank pits being connected by a pipe extending the length of the engine, underneath the bedplate. The flanges for securing the engine to the ship are drilled for a total of fifty-six 2-inch bolts.

Frames

The frames are cast iron of the "A" type and box section. The lower part of each leg on the side toward the

Fig. 4.—Showing "A" Frame Construction

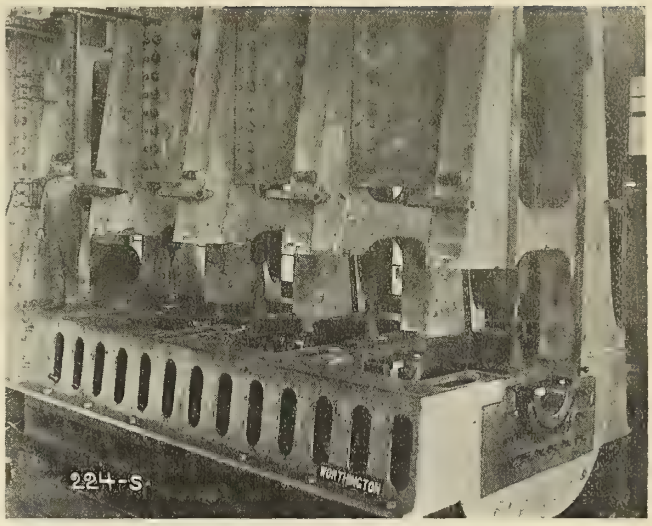


Fig. 5.—"A" Frame With Section Removed to Receive Shaft

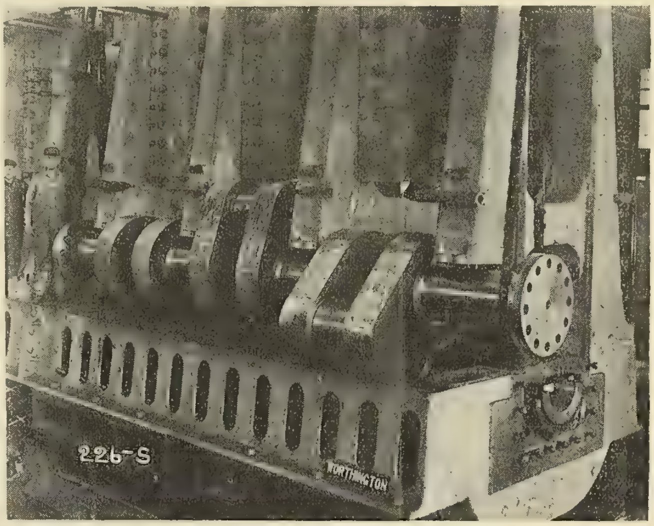


Fig. 6.—Main Shaft Partly in Frames

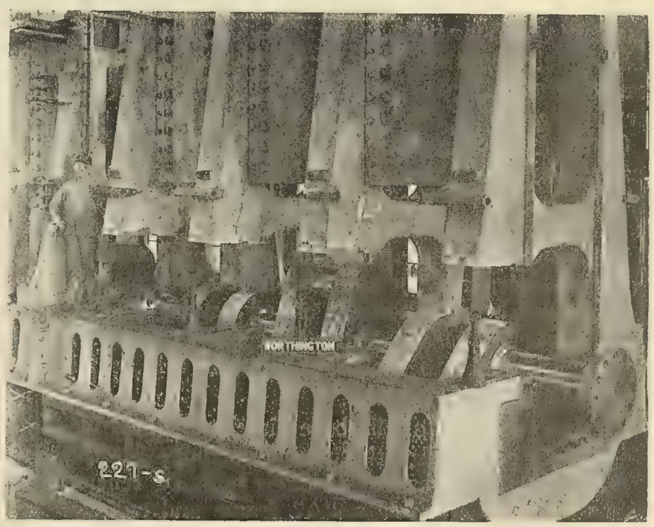


Fig. 7.—Shaft Dropped in Journals

longitudinal center of the ship is cast separate in the form of a distance piece, with machined joints, so that in the event of replacing a main shaft the distance pieces can

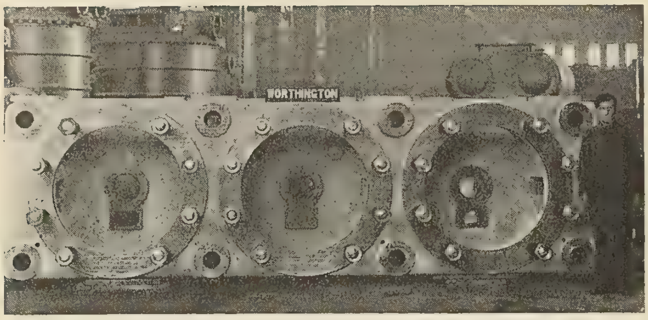


Fig. 8.—Top View of Cylinder Base Plate

be removed and the shaft taken out without dismantling the entire engine, as shown in Figs. 5, 6 and 7. The joint between the "A" frame and the loose member is made with a slight taper to facilitate its removal. When in position it is secured to the "A" frame by bolts and a key. Suitable ledges are provided on the "A" frames for supporting the crosshead guides and the splash plates.

Cylinder Base

Between the tops of the "A" frames and the bottoms of the cylinders is a cylinder base cast in two sections and joined by a distance piece. Each section of the cylinder base rests on four "A" frames and supports three power cylinders. Necessary strength without excessive weight is attained by a circular member surrounding the cylinder fitting-piece, from which radial ribs lead to the four bosses carrying the vertical through bolts which take the load of the particular cylinder.

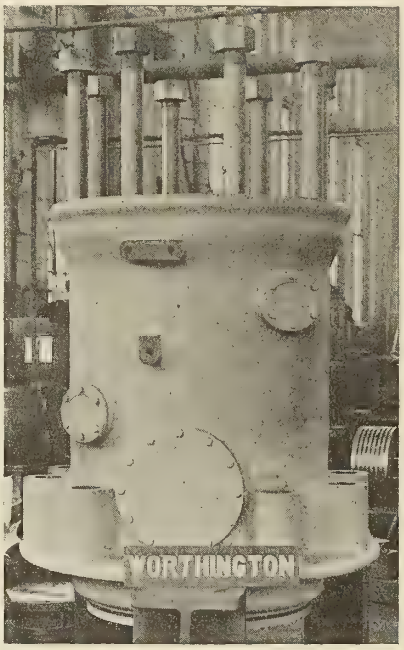


Fig. 9.—Cylinder; Weight, Including Liner, 9,000 Pounds

On the back face an opening is provided, permitting access to the piston rod stuffing box and inspection of the cylinder bore. The front face has a similar opening, making the base plate symmetrical in form.

The bottom member of the base plate is cast solid, the necessary openings for the piston rod and piston water service tubes being effectually closed against leakage. This makes it impossible for any cylinder oil or piston water leakage to pass into the crank pit and mingle with the lubricating oil.

The two sections of the base plate are joined by a distance piece provided with suitable openings for the camshaft gear. The vertical through bolts or tension rods pass through the bedplate, "A" frame and cylinder base and fit in the upper side of the bedplate and in the under side of the cylinder base for a distance equal to the diameter of the bolt. This arrangement is adopted to increase the rigidity of the structure. The bolts are of open hearth forged steel and are turned to a diameter below the root of the threads.

Each pair of tension rods passes through the bedplates close to a main bearing, so that the stress due to pressure in the cylinders is taken on the main bearing without putting the "A" frames in tension.

Cylinders and Cylinder Heads

The power cylinders are of soft cast iron. The liner is a separate casting of hard iron, providing a durable wearing surface, the space between the liner and cylinder forming the water jacket. The liner is a close fit in the cylinder at its upper end, and the lower end is free to expand and contract with the changing temperature. The joint between the liner and cylinder at the lower end is made tight by a rubber ring which is held in place by a gland. There are four handhole plates at convenient locations in the outer wall, giving easy access to the jacket space for inspection and cleaning.

Each cylinder is secured to the cylinder base by eight bolts passing through deep lugs, symmetrically located on the circumference and joined at the bottom by a heavy flange. These bolts pass through the cylinder base and are secured by nuts under the bottom of base, thus putting the structure of the base in compression instead of tension.

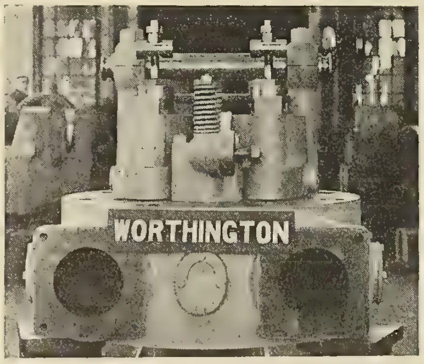


Fig. 10.—Back View of Cylinder Head and Valve Assembly

Each cylinder head is of cast iron and carefully designed to secure symmetrical arrangement of the valve openings and equal distribution of the metal. The inlet and exhaust valve casings are placed on the longitudinal centerline with ample water passages around the valve space walls. The spray valve casing is placed off of the longitudinal center toward the valve gear side, and the casing wall is formed by a copper tube. This arrangement still further increases the water and core space, and assists in freeing the head from shrinkage strains.

The cooling water enters the cylinder jacket at the lower end and flows upward, passing into the head through a series of holes cored in the top face of the cylinder adjacent to the outer wall and symmetrically spaced around the circumference. A corresponding series of holes is placed in the lower face of the cylinder head. The water then passes through a hole in the top of the head into the exhaust valve casing. A relief valve is placed in the head to prevent the occurrence of abnormally high pressure.

The air supply to the cylinder is taken in through a vertical slotted pipe extending above the cylinder head.

Fig. 11.—Half Section of Main Shaft. Weight, Each Half, 41,000 Pounds

The piston, of cast iron with concave-shaped head, is made with a central column extending from the top to the lower face and bearing against the piston rod. This serves to distribute the stress uniformly and relieve the head from carrying the entire load. There are eight Wasson piston rings, the first ring being placed as far as possible from the top face in order to remove it from the area of intense heat. The rings have beveled edges to prevent cutting and facilitate cylinder lubrication.

Pistons and Piston Rods

The upper end of the piston rod is formed into a large flange and the piston rests on this flange. The rod is secured to the piston by studs threaded into the piston and fitted with lock nuts.

The piston is arranged for water cooling. The cooling water enters the head at the circumference, flowing through a cored passage to the inside of the center column. It rises in the center column, flows out through cored passages to the main body of the piston, filling this body and spreading out uniformly against the under surface of the piston head, and then is discharged through four vertical pipes spaced around the circumference of the piston and connecting with a circular passage at the bottom of the piston from which the water flows to the discharge pipe. The upper ends of the vertical pipes are close to the under surface of the piston head to insure the piston being full of water at all times and to prevent air pockets.

The piston rod, of open hearth forged steel, is flanged at the upper end to approximately the diameter of the cylinder bore, in order to distribute the load over the piston area. The rod is reduced in diameter where it passes through the crosshead, so that a large shoulder is formed which rests on the crosshead. The reduced portion of the rod passes through a hole in the crosshead and is threaded at its lower end to receive a nut for securing the crosshead tightly to the rod. This nut is slotted to receive a key spanner for screwing and unscrewing. Where the rod passes through the bottom of the cylinder base it is packed with metallic packing to prevent cylinder oil or water from leaking into the crank pit.

Connecting Rod and Crosshead

The connecting rod is of open hearth forged steel, of standard marine design, with forked crosshead end and with a "T" head at the bottom for stepping on the crankpin box. The rod is hollow and the axial hole is utilized for supplying oil to the crosshead pins. The crank and crosshead pin boxes are of cast steel lined with high grade white metal. The two halves of the crankpin box are interchangeable, so that when the upper half has worn it may be replaced by the bottom half.

The crosshead is of open hearth forged steel. The body consists of a square forging, bolted to the cast steel slipper. Projections fore and aft from the body form the crosshead pins for receiving the boxes of the forked connecting rod. The cast steel slipper is secured to the crosshead body by through bolts and its surfaces are faced with white metal. The backing surface is approximately two-thirds that of the ahead surface. Diagonal holes are drilled through the slipper, through which oil from the ahead guide may flow to the backing guide. The body of the crosshead is bored to receive the reduced portion of the piston rod end. The usual tapered fit at this point is not necessary, as the greatest upward pull is slight compared with the downward thrust.

The crosshead slipper runs on a water cooled guide. The crosshead guide is of cast iron, of box section, and is secured to flanges on the "A" frames. As the principal thrust comes on the inboard side of the engine, the guides are placed there. While running astern, the thrust is taken by backing strips, secured to the main guide by through bolts.

Crankshaft and Thrust

The crankshaft, of open hearth forged steel, is built up in two sections, each section having three cranks. Each crankpin is forged integral with two webs. The main bearing sections are secured to the cranks by shrink fits and keys. The two sections of the shaft are interchangeable and are fitted together by flange couplings fitted with taper bolts.

The thrust shaft forms an extension on the aft end of the crankshaft and is secured to the latter by a flanged coupling and bolts. It is carried in a base which is secured to the aft end of the bedplate and to the ship's members. The thrust bearing is of the Kingsbury type.

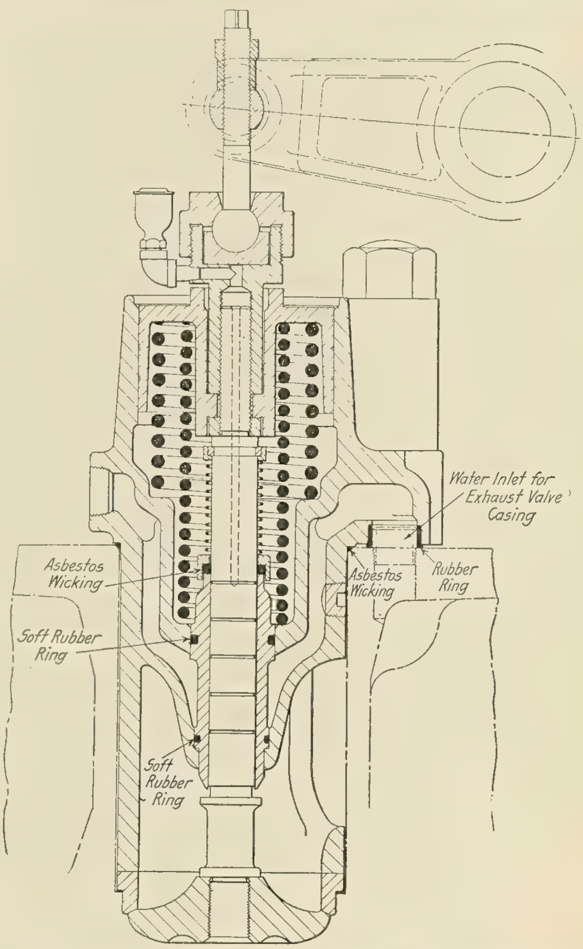


Fig. 12.—Section Through Exhaust Valve

Immediately aft of the thrust shaft bearing and located on the thrust shaft is a flywheel cast in halves, bolted and keyed to the shaft and secured at the rim by shrunk keys. All the flywheel load is thus taken off the aft main shaft bearing and the tendency of that bearing to wear reduced. The flywheel has teeth cast in its rim which engage with the worm on the turning engine shaft.

Valves and Valve Gear

The inlet and exhaust valves are symmetrically placed on either side of the center of the head and are interchangeable, as the casings and valves are duplicated throughout. This makes it necessary to carry but one set of spares. The valve disk is of cast iron; the stem is of forged steel and is threaded into the disk with the end riveted over. The stem is made of large diameter in order

to promote rapid heat transfer. The valve seat is formed on a ring separate from the valve cage so that the seat can be readily renewed, if necessary, without renewing the complete cage. The joints between the valve cage, valve seat and cylinder head are flat, so that in setting up for tightness no splitting stresses are set up in the head, as would be the case with tapered joints. The valve seat is of cast iron and both the valve and valve seat are cast in a chill and finished by grinding.

Attached to the upper end of the valve stem is a cylindrical guide of large diameter, which is housed in a bored extension of the valve casing and which maintains the alinement of valve and stem. The lower part of the valve stem is further guided by a long, removable, cast iron bushing, at the upper end of which is a stuffing box and gland to prevent the lubricating oil being blown out by the exhaust pressure. This gland is held in place by a coil spring which bears against the lower end of the valve stem guide. This spring is compressed when the valve is opened, so that the maximum pressure against the packing is exerted only when the exhaust gases are passing through the valve. The valve cages are provided with a water jacket, but water is used only in the exhaust valve cage. The joints between the removable bushing and the valve cage body are made tight against water leakage by soft rubber rings held in circumferential grooves.

The bearing surface of the valve stem, where it is guided by the removable bushing, is provided with circumferential oil grooves and lubricating oil is supplied through an axial hole from an oil cup on top of the stem.

The pin by which motion is transmitted from the valve lever to the valve is attached to the upper part of the valve guide by a ball and socket joint. The valve springs are two in number and are supported on the lower part of the casing and bear against the under side of the valve stem guide, which is made cup-shaped to receive them.

A combined spring compressor and lifting device is provided by which a complete valve and cage assembly may be easily removed from the cylinder head and disassembled on the work bench.

Auxiliary Exhaust Valve a New Feature

At the lower end of the cylinder is an auxiliary exhaust valve in communication with a port in the cylinder liner which is uncovered by the piston near the end of its stroke. The valve is self-contained in a water-jacketed casing which is readily removable and is fitted with a dash pot which prevents pounding of the valve in either direction. A jacketed pipe connects each casing with the main exhaust pipe.

The valve is normally held on its seat by a spring, but when its port is uncovered by the piston at the end of its stroke the pressure inside the cylinder overcomes the resistance of the spring and the valve opens, permitting the hot gases in the cylinder to discharge into the exhaust line. When the piston moves upward on its return stroke it covers the port and the valve is seated by the spring pressure acting behind it. The gases that are left in the cylinder at low pressure are then forced out through the main exhaust valve in the usual way. By this means the first and hottest portion of the exhaust gases are discharged through the auxiliary valve, thus relieving the main exhaust valve of this duty, prolonging its life and requiring less frequent grinding of valve and seat.

When starting the engine with air the auxiliary valve relieves the pressure at the end of the stroke before the main valve opens and thus relieves the exhaust valve operating gear of a large part of its load.

Spray Valve

The fuel spray valve is a steel, long stem, disk valve working through a long guide and stuffing box on a conical seat. The valve body is in four main parts. The outer tube fits in the copper casing through the cylinder head and its lower end is provided with a square shoulder that makes a jo nt on a flat seat at the bottom of the opening

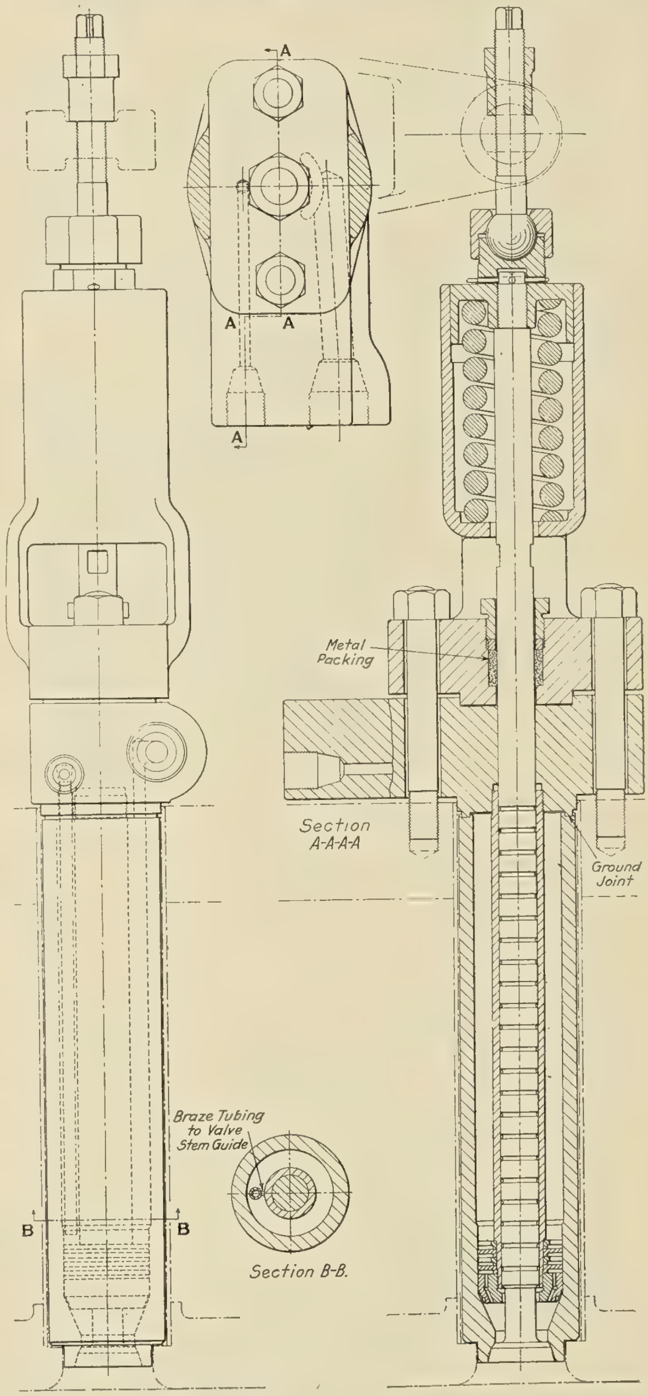


Fig. 13.—Details of Spray Valve

through the head. This joint is made tight with a McKim gasket. The inner tube, which forms a guide for the valve stem, is concentric with, and smaller in diameter than, the outer tube, so that there is an annular space between the two. The inner tube is accurately centered in the outer tube by means of the pulverizer rings at its lower end and a cover block into which its upper end is threaded. This cover block seats on top of the outer tube with a male and female ground joint. It contains the drilled pas-

sages through which fuel oil and spray air are admitted into the valve body.

Seated on top of the cover block, with a McKim gasket, is the valve cover, which is bored and threaded for a packing gland where the valve stem passes through. This valve cover is extended at the top to form a spring cage which is bored at its upper end to receive a cylindrical guide of large diameter. This cylindrical guide is threaded on the upper end of the valve stem. It guides the valve stem and its under side acts as a bearing for the valve spring.

The valve has a cone seat and the oil spray is discharged into the cylinder in the form of a diverging cone. The pulverizer through which the oil is forced before passing through the valve consists of a series of thin disks placed one on top of the other in the annular space between the inner and outer tubes and separated by small shoulders around their inner peripheries. Each disk contains a number of thin, radial slots and the disks are so placed that the slots are staggered, thus forming a tortuous path for the oil.

Extending downward in the annular space between the inner and outer tubes, from the oil passage in the cover block to a point just above the upper disk, is a vertical pipe which deposits the fuel oil on the top of the upper pulverizer disk. The annular space communicates with the air passage in the cover block, so that it is always filled with air under a pressure of 800 to 1,000 pounds per square inch. The oil spreads out over the surfaces of the disks, and when the valve is pushed open by the valve lever the high pressure air rushes through the pulverizer disks and sweeps the oil into the cylinder in a finely divided form.

The valve stem at its upper end is attached to the valve lever by means of a ball and socket joint similar to that described with the inlet and exhaust valves. The complete valve assembly is held in place by two stud bolts which pass through the valve cover and cover block and screw into the cylinder head.

Air Starting Valves

The air starting valves, one for each cylinder, are attached to the inboard side of the cylinder base, adjacent to the camshaft bearings and beneath the camshaft, the valve being directly under the centerline of the camshaft. The air starting cam acts directly on a roller in the end of the valve stem, no levers or reach rods being required. The valve is of the mushroom type, with the stem enlarged to form a guide. Normally the valve is in its bottom position and open. In this position the roller on the end of the stem does not make contact with the cam.

When the starting air is turned on from the operating platform, the pressure raises the valve to its seat and holds it firmly closed, or brings the stem in contact with its cam, depending on the position of the latter. The valves are then in position to be operated by the camshaft. The starting air is discharged into the cylinders by means of a short pipe connection between the starting valve and the check valve on top of the cylinder.

Valve Levers and Push Rods

The inlet, exhaust and spray valves are operated by cast steel levers mounted on fulcrum shafts which are carried by two stanchions secured to each cylinder head. With this arrangement the valve driving gear is independent for each head, permitting renewal without disturbing its alinement. As previously noted, the connection between each valve and its lever is by means of a ball joint.

The motion from the cams to the valve levers is transmitted through push rods of seamless drawn steel tubing with solid steel ends shrunk in. The lower ends are forged and carry the cam rollers on pins of ample dimensions. The location of the air starting valves under the cam shaft instead of on the cylinder head eliminates one push rod and valve lever at each cylinder. Space is thus provided for extra large cam roller pin bearings, reducing wear and noise. The push rods are guided at their lower ends by links pivoted on the reverse shaft cranks.

The camshaft is carried in brackets supported on the side of the cylinder base plate, each bracket containing a bearing formed of two die cast half shells of bearing metal with adjustable caps. The shaft is in three sections, a middle one upon which the driving gear is mounted, and two end sections each carrying the cams

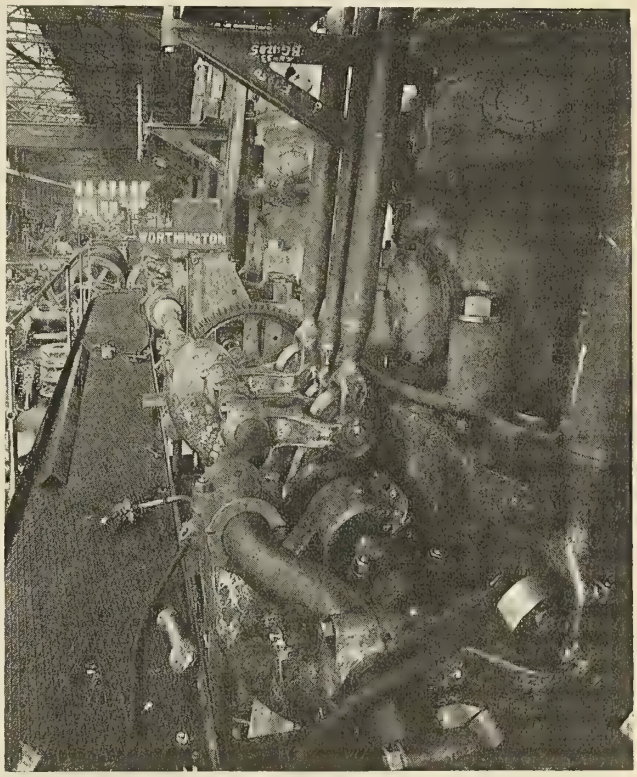


Fig. 14.—View from First Platform, Showing Valve Gear

for three cylinders. Flange couplings joining the two end sections to the middle sections are placed on either side of the two center bearings.

Camshaft and Cams

The camshaft is driven from the main shaft by a train of helical cut spur gears, located at the center of the engine. The first gear is mounted on the main shaft coupling and is in halves bolted together. Following are two idler gears running on shafts which are clamped to brackets supported on the adjacent "A" frames. The next gear is carried in a similar manner and has bolted to it the half speed gear with which the gear on the camshaft meshes. The brackets supporting the gear shafts rest on adjustable studs by means of which the gears can be brought into correct mesh.

The spray valve cams are adjustable for timing the injection of fuel. This adjustment feature is secured by making each spray cam in two parts. A small flange is keyed rigidly to the camshaft and the cam is mounted on this flange, being secured to it by bolts. The bolt holes through the cam are slotted, so that the cam may be rotated on the flange. Two lugs project from one side of the

cam, and threaded through these lugs are set screws whose ends bear against the opposite sides of a lug projecting from the side of the rigid flange. The cam is rotated on the flange for adjustment by screwing out one set screw and screwing in the other. When correct adjustment is secured both set screws are set up tightly and the nuts on the securing bolts are tightened, thus securing the cam rigidly in position.

Taking the cams of one cylinder in the order in which they operate, the succession is as follows:

Five degrees before top center the spray valve is opened by its cam, which holds it open through the first 49 degrees of the down stroke, thus keeping the valve open through 54 degrees of a revolution. The spray valve then closes and expansion takes place until 138 degrees from the top of the stroke, when the auxiliary exhaust port is uncovered by the piston and the auxiliary exhaust valve opens.

At 6 degrees before the bottom center the main exhaust valve is opened by its cam. The auxiliary exhaust valve closes at 42 degrees past the bottom center, but the main exhaust valve is held open by its cam until 14 degrees after the top center, or through 200 degrees of a revolution of the crankshaft.

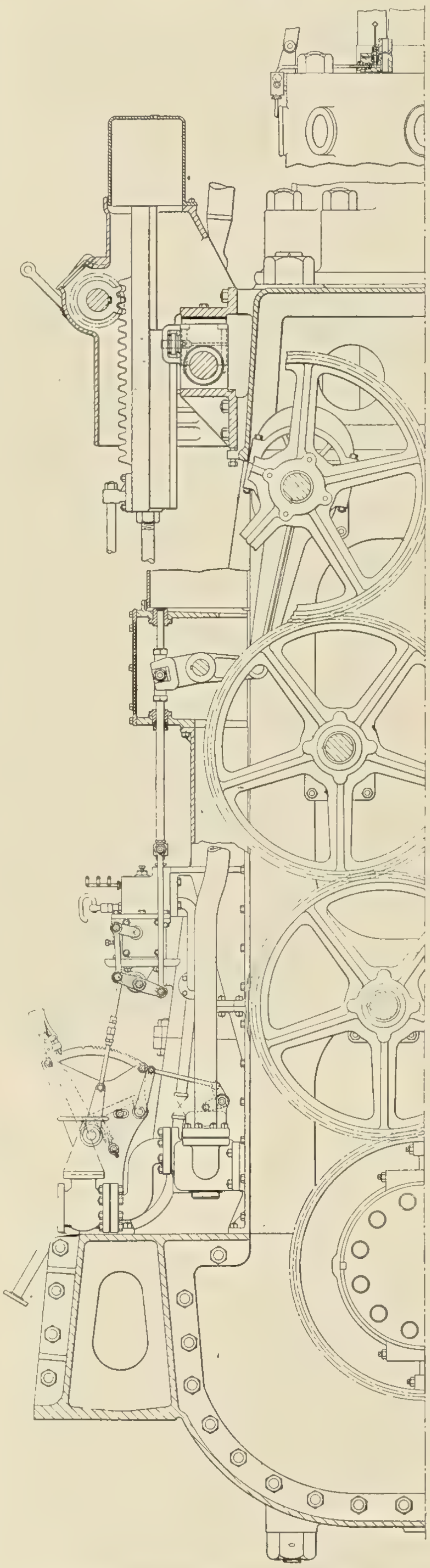


Fig. 15.—Operating Gear, Side View

At 22 degrees before the top center, on the upward stroke of the piston, the inlet valve opens and is held open by its cam during the whole of the down stroke of the piston and until 34 degrees past the bottom center, or through 236 degrees of a revolution. Compression then begins and is maintained until 5 degrees before the top center, when the spray valve is again opened and the cycle begins again.

It will be noted that the inlet and exhaust valves are open at the same time during 36 degrees of a revolution. The reason for this is that at this point the exhaust gases are flowing rapidly out through the exhaust valve and the cylinder volume is decreasing very slowly, due to the slight motion of the piston at this point in the stroke. The inertia of the exhaust gases maintains their flow after they have ceased to be acted upon by the piston, thus creating a depression of pressure in the cylinder which helps to start the flow of fresh air into the cylinder through the inlet valve.

The air starting valves and cams are in operation only when the engine is being started. These valves open at 2 degrees past the top center and close at 130 degrees, being open during 128 degrees of a revolution. The order of firing is No. 1, 5, 2, 6, 3, 4 ahead and No. 1, 4, 3, 6, 2, 5 astern.

Method of Reversing the Engine

The reverse shaft is of forged steel and extends parallel to and inboard of the camshaft, being carried in babbitted bearings on the same brackets that support the camshaft. It is formed with cranks opposite each cylinder on which are pivoted the guide links, which are attached to the lower ends of the valve push rods. These guide links serve the double purpose of guiding the push rods and pulling the rollers out of the area of contact with the cams when reversing.

There are two sets of cams on the camshaft, and reversing is accomplished by sliding the camshaft, bringing the second set of cams under the rollers. The construction and operation of the reversing mechanism is as follows:

The camshaft carries a block which slides on a bearing secured to one of the center "A" frames and which carries rollers engaging a cam plate, straight for a portion of its length at each end and curved in the center. This latter is attached to the piston rod of an air cylinder mounted on the "A" frame leg. Secured to the piston rod and adjacent to the cam plate is a rack which engages a pinion on the reversing shaft. When the air is admitted to the operating cylinder the pinion begins to rotate and pulls the cam rollers out of the area of contact with the cams. During this movement the straight part of the cam plate is passing the rollers on the camshaft block, so that no longitudinal motion of the latter takes place. As soon as the cam rollers are pulled out of area of contact the curved portion of the cam plate engages the camshaft block and the camshaft is shifted, bringing the second set of cams under the rollers. The remainder of the air cylinder stroke completes the revolution of the reverse shaft and brings the roller back onto the cams. During this period the other straight end of the cam plate is in contact with the rollers so that no movement of the camshaft takes place.

Above the air cylinder is an oil cylinder by means of which the rapidity of movement of the gear can be controlled and shocks prevented.

Operating Gear

The main control of the engine is by two levers, one for the forward three cylinders and the other for the aft three. These levers are located side by side at the center of the length of the engine and are operated from the engine room floor. The first movement of either lever admits the starting air, and further movement closes the

air and admits the fuel oil, continuing movement increasing the amount of oil up to maximum load. Separate control of each three power cylinders makes possible a lower minimum speed, as by operating on one-half of the cylinders the power developed per cylinder is doubled, insuring regularity in burning of fuel and increasing the flexibility of the engine.

For reversing, a lever is located to the left of the main operating levers and adjacent to the reversing air cylinder. This lever controls two mushroom valves which admit air to either end of the reversing cylinder, which is completely interlocked with the main operating levers so that it is impossible to shift the reverse gear when either the starting air or fuel is on, or start the engine with the reverse gear off of either ahead or astern position. A bar

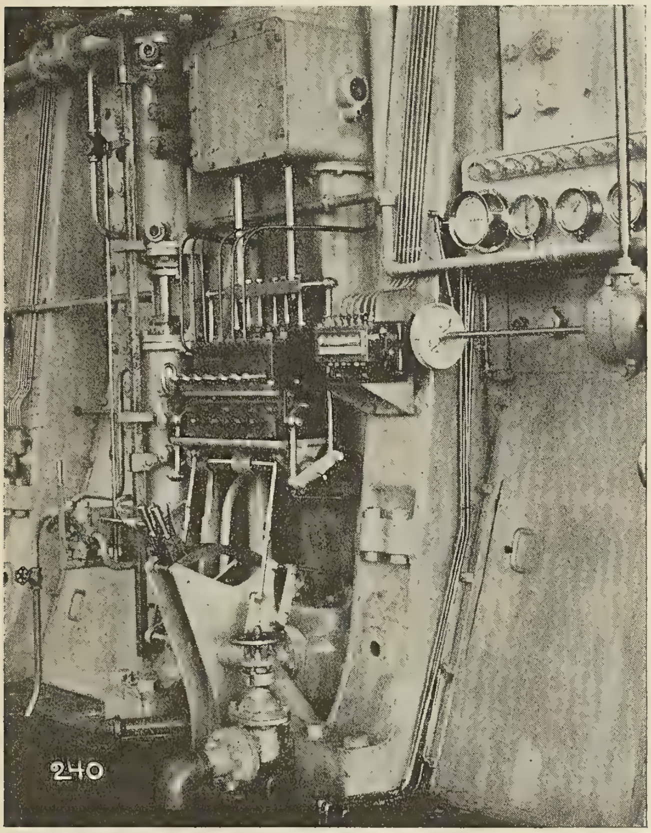


Fig. 16.—Fuel Pump and Operating and Reversing Gear

connected to the air cylinder piston rod serves to return the reverse lever to mid position near the end of the stroke in either direction, shutting off the air from the cylinder, and at the same time to release the lock on the main operating levers, permitting of starting of the engine. There is also a valve at the operating station which controls the main starting air supply and which is closed when maneuvering is completed.

The main supply line from the storage tanks leads to a casing at the operating station containing two valves, each connected to one of the operating levers and controlling the air to three power cylinders. From each one of these valves a pipe extends upward and then along the cylinder base in each direction, supplying the air to the operating valves. From the latter, separate pipes lead to the cylinder heads where suitable check valves are located. The air pressure for starting and maneuvering is 375 pounds per square inch.

The compressor for furnishing the spraying and starting air is located at the forward end of the engine and is driven from a crank on the end of the main shaft. The compressor cylinders are arranged tandem and are supported on a housing which rests on the ship members and is bolted to the engine base and forward "A" frame.

AIR COMPRESSOR

The compressor is of the three stage type, the second stage being obtained by a differential piston. The first and third stage discharge occurs on the up stroke and the second stage on the down stroke. An extension of the piston carries the wrist pin and forms a crosshead which runs

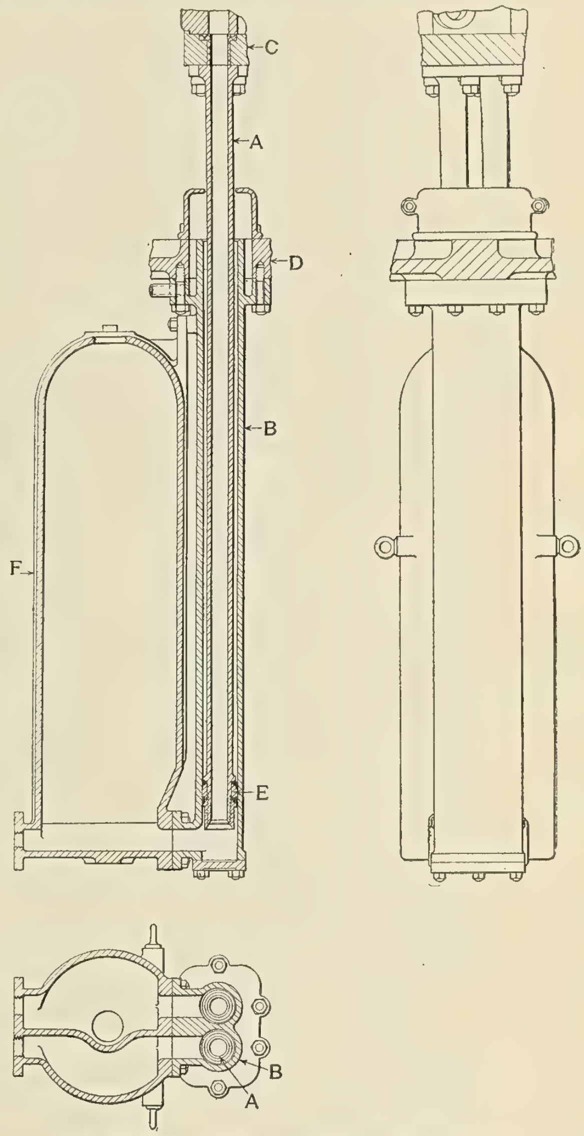


Fig. 17.—Details of Piston Cooling Mechanism

in a bored guide in the compressor housing. The cylinders are cast with double walls, the space between forming the water jackets. Removable liners are fitted to all of the cylinders, providing durable wearing surfaces for the pistons. There are two cylinder castings, the lower one resting on the housing, containing the first and second stage, and the upper one the third stage.

Laidlaw feather valves (patented) are used for both suction and discharge on all stages, insuring freedom from valve trouble. There are two suction and two discharge valves each on the first and second stages and one each on the third stage. The discharge valves throughout are water jacketed to prevent excessive temperature and consequent carbonizing of the lubricating oil.

The valve seat is a cast iron grid of disk form, the slots through the grid forming the air passage and the

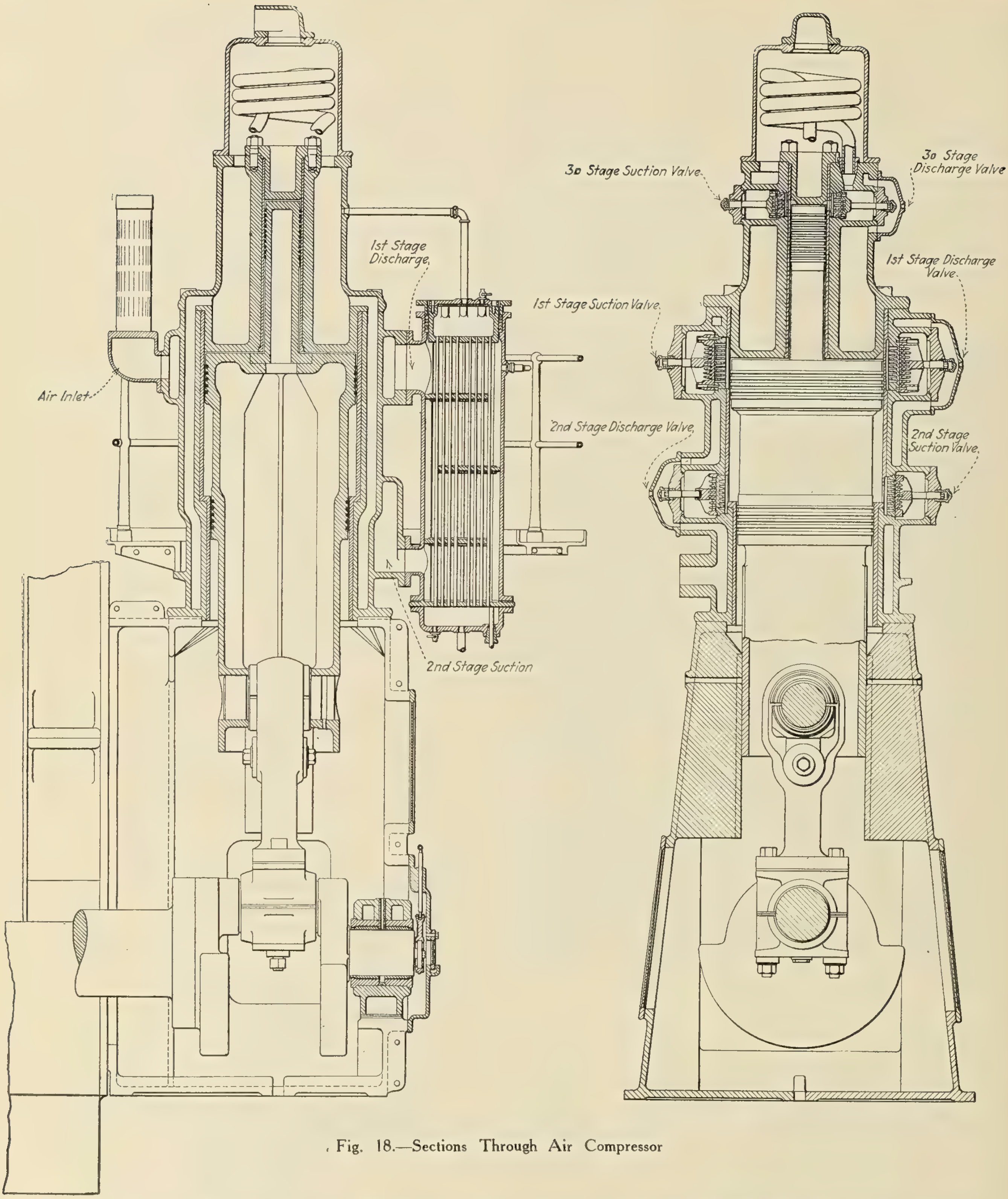


Fig. 18.—Sections Through Air Compressor

bars forming the seat for the valve strips. Seating on top of the grid and covering the slots are thin, flexible strips of steel, held in place by a second disk grid resting on top of and bolted to the first grid, in such a position that the bars on the second grid coincide with the slots in the first grid. The bars of the second, or cover grid, are milled out to a concave shape, so that when pressure comes under the valve strips they are free to bend or bow upward, thus making a passage for the air to flow through. When the excess of pressure under the valve strips ceases they straighten out and seat firmly on the flat topped grid. The ends of the valve strips, when the center lifts, remain in contact with the seat, so that the closing of the valve strips, instead of being an impact, becomes merely an increase in the point of contact. The whole valve unit fits into a cone-shaped opening and is held in place by a single stud through the valve bonnet. The intake and discharge valves are identical and interchangeable.

The compressor is of ample capacity to provide spraying air for the engine when operating at a minimum speed, and to fill the maneuvering air tanks and supply the spraying air at full speed. In order that the compressor may operate efficiently at full speed when a minimum amount

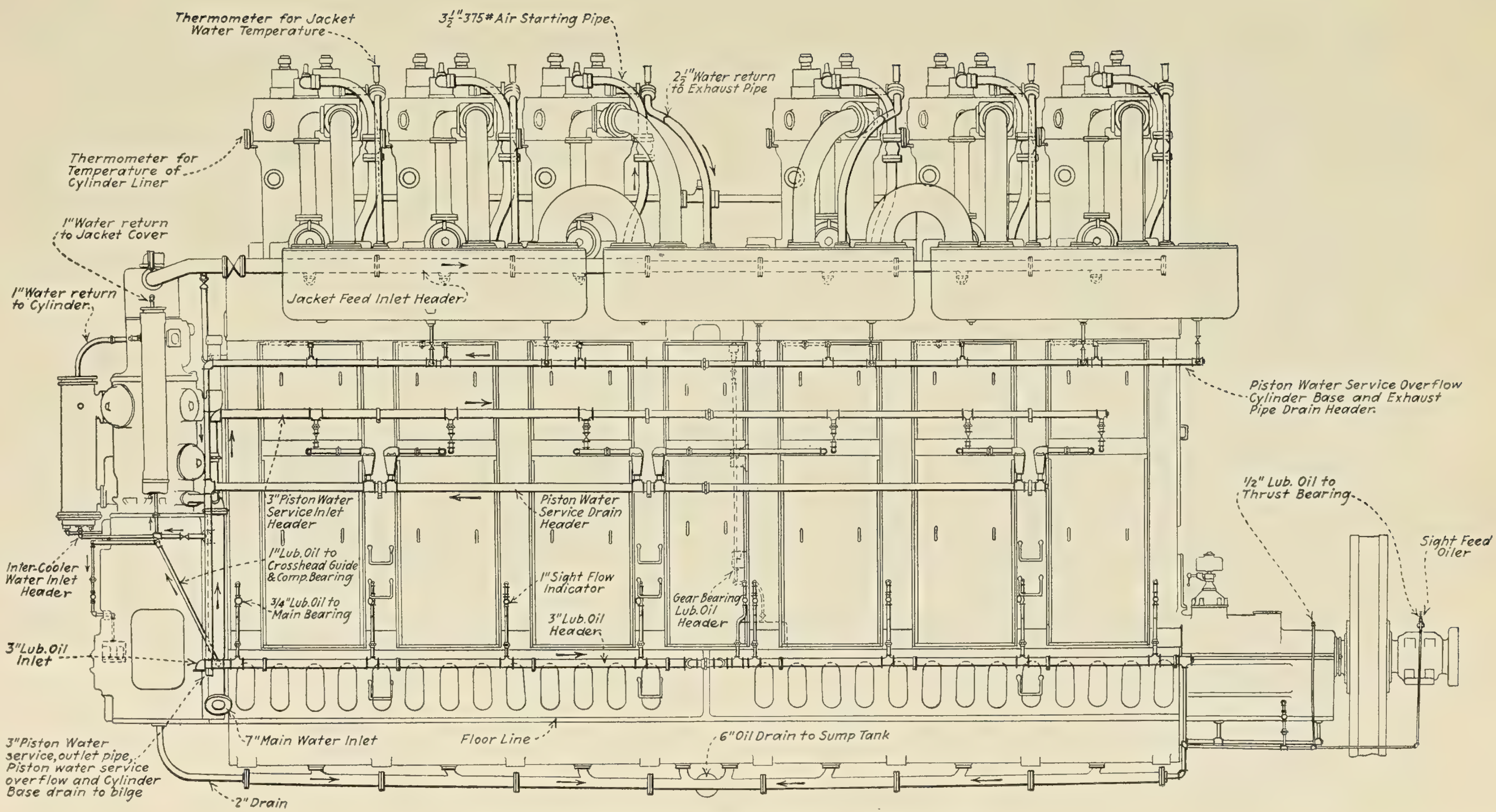


Fig. 19.—Back of the Engine, Showing Details of Piping Arrangement

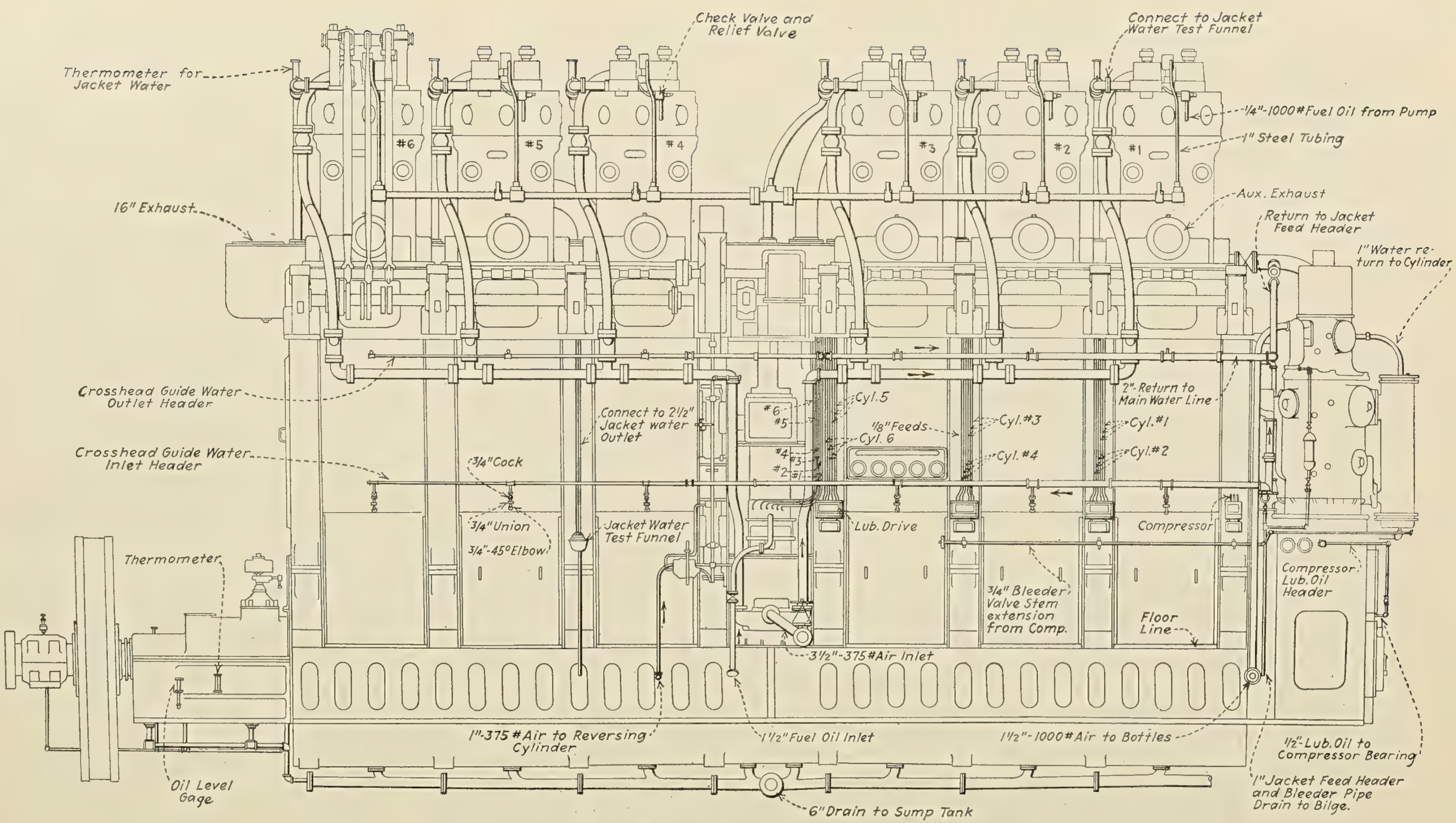


Fig. 20.—Inboard, or Operating, Side of Engine, Showing Arrangement of Piping

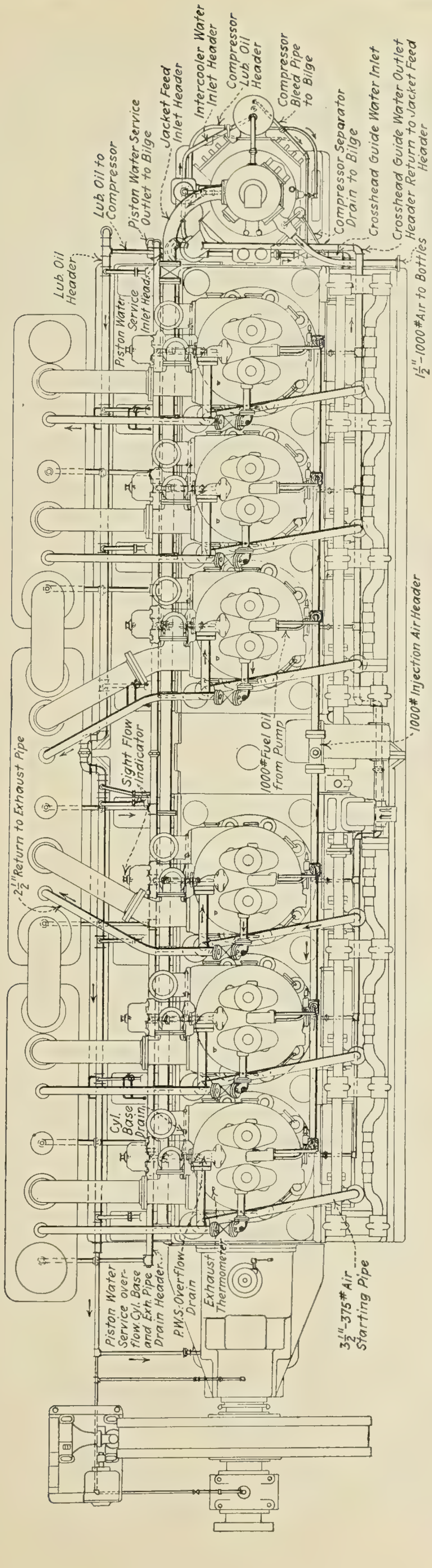


Fig. 21.—Top of Engine, Showing Arrangement of Piping

of air is required, a valve is provided which bleeds the first stage discharge air into the bilge and which is closed when the maximum capacity is needed. This valve is controlled from the main operating stand.

Governor

A centrifugal, spring loaded governor is located just forward of the thrust bearing and is driven from a ring gear attached to the forward thrust shaft coupling flange. This governor serves as a safety stop only, cutting off the fuel oil supply from five of the six cylinders when the speed increases about 10 percent over normal. This control is omitted from the sixth cylinder in order to prevent the possibility of stalling the engine when the governor acts.

The governor acts through reach rods and a shaft to operate a bar which lifts the rocker arms beneath the suction valves of the fuel measuring pumps, holding the valves open during the entire discharge stroke.

Fuel Oil System

Fuel oil is drawn from the main storage tanks by an independent motor driven pump, from which it is forced to the gravity tanks from which it flows to the suction chamber of the fuel measuring pumps.

The six working cylinders are provided with individual measuring pumps. These are contained in a single unit mounted on the inboard side of the engine between "A" frames 4 and 5, directly above the operating platform. The six vertical, single acting plungers are driven in unison by a single bar which receives its motion from a small walking beam mounted in a box directly above the pump unit. This beam receives its motion through an eccentric arm from an eccentric mounted on the spindle of the upper gear of the camshaft gear train. The pump driving bar is located above the pump plungers and the plungers are attached to it in such a manner that any one plunger can be removed without disturbing the others.

Piping

The piping on the engine may be divided into six systems, namely, air starting, spray air, fuel oil, cooling water circulation, lubricating oil and exhaust.

Air Starting System. The starting air is supplied to the engine from the starting air tanks, which are kept filled to 375 pounds pressure by by-passing some of the air from the main engine air compressors, or which can be filled by an auxiliary motor driven compressor. The starting air from the tanks passes through a stop valve at the tanks, through the main supply pipe to the operating station on the inboard side of the engine, and through a stop valve to a casing just behind the operating levers. This casing contains two piston valves, each valve connected to one operating lever by reach rods and bell cranks. From each valve an outlet pipe leads up to the level of the starting valves, then along the inboard side of the engine, each pipe supplying the starting air for three cylinders.

When standing by for maneuvers the stop valves are open and the starting air is up to the control valves in the casing. When maneuvering is completed and the engine is in operation the stop valve at the operating station is closed.

In port, where the engines are not to be used for some time, the stop valve at the tanks should also be closed.

Spray Air System. Spray air is supplied from the spray air flasks located near the operating station. Air at 1,000 pounds pressure is pumped into these flasks from the main engine air compressors, or they may be supplied from the motor driven auxiliary compressor. While the

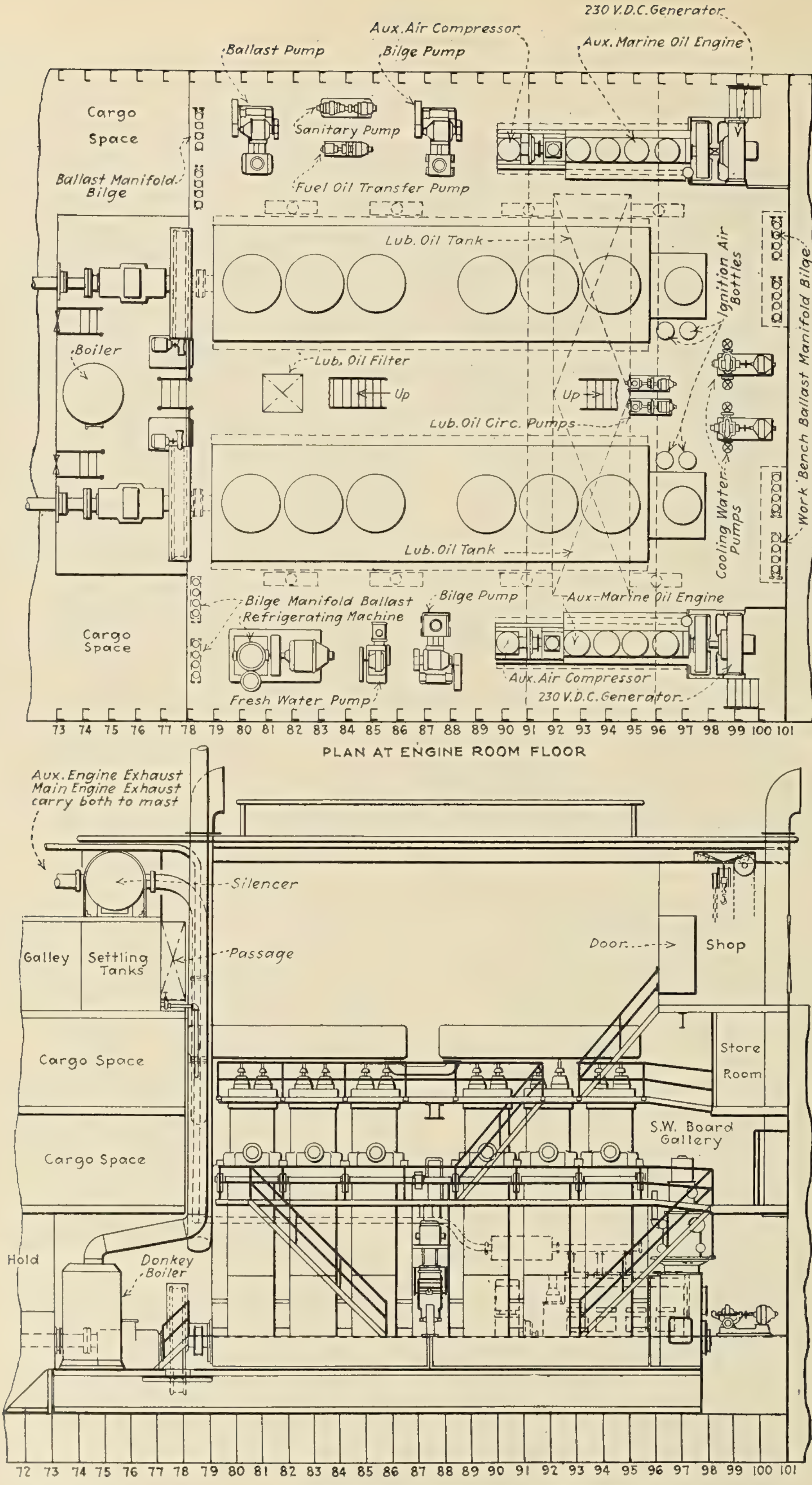


Fig. 22.—Plan and Longitudinal Sectional Elevation of Engine Room for Proposed Twin-Screw Vessel Equipped With Worthington Diesel Engines and Auxiliaries

engine is running, one spray air flask is in series with the air compressor so that the air is supplied to the engine from the compressor and the flask tends to reduce any fluctuations in pressure. The second flask is in reserve and cut out. At the point where the discharge line leaves the header a separator is installed in the line for removing oil and water from the air.

At the inlet to each air flask is a 1-inch pressure relief valve which is always in communication with the air line from the compressor, whether the stop valve at the air flask is closed or open. The outlet from each flask is provided with a stop valve so that the flasks may be charged while air is shut off the engine. An opening for connecting a pressure gage is provided in the top of each flask and closed by a valve. All valves on the flask are provided with double seats so that when the valve is wide open no leakage can occur around the stem. The inlet opening to the flask is extended down to about one-half the depth of the flask. In the bottom of each flask is a drain opening with drain pipe and stop valve, for draining out water and oil.

The outlet pipes from the starting air flasks join into a single pipe which leads to a header on the inboard side of the engine. This header extends fore and aft along the engine, with a branch to the spray valve on each cylinder. Each branch pipe is carried above the level of the opening in the spray valve before bending down to meet the valve. This prevents the possibility of fuel oil from the spray valve leaking into the spray air pipe where it might become ignited.

Fuel Oil System. Fuel oil is drawn from the large storage tanks by an independent motor driven pump and discharged to an elevated gravity tank. From the gravity tank it flows to the suction box of the fuel pump unit at the operating station. This suction box is always full, due to the head from the elevated tank. A stop valve is provided in the line for shutting off the oil when it is desired to open up the suction box. Each pump in the fuel oil measuring pump unit has its own discharge pipe which leads to the cylinder supplied by that pump. A check valve is placed in each line near the spray valve. Where the oil line joins the spray valve is a by-pass valve, which may be opened when pumping oil through the line to clear it of air, or which may be used for cutting out that cylinder.

Cooling Water Circulating System. This system comprises the air compressor and intercooler, main working cylinder jackets and heads, exhaust valve cages, exhaust header, main guides and piston. Sea water is used throughout. The cooling water is supplied by a motor driven centrifugal pump.

From the pump a 7-inch inlet pipe goes to the air compressor jacket on outboard side. Small branches run to the bottom of each intercooler and discharge from top of intercoolers to the third stage jacket. From the top of the third stage jacket a 6-inch discharge line runs the length of the engine on the outboard side, with a branch connecting to the bottom of each working cylinder jacket. The water rises in the jackets, passes through the cored openings into the cylinder head jacket space, through the exhaust valve cage jacket space, out through a 2½-inch pipe from each exhaust valve cage to the exhaust header jacket, and thence overboard.

At a point near the outlet from each exhaust valve cage a thermometer is placed in the line so that the temperature of the cooling water from each individual cylinder may be noted. Connected to each outlet from the exhaust valve cage is a small test pipe which is led to a funnel on the inboard side of "A" frame 8, in order that the attendants may observe the flow of water from each separate jacket.

At a point near where the main inlet pipe joins the air compressor jacket a 3-inch line branches and runs the length of the engine on the outboard side. Opposite each working cylinder a branch from this line joins the piston cooling inlet pipe and the water passes up through a telescopic tube to the piston. The return from the piston is through a twin telescopic tube and out through a pipe to the piston cooling return water header. Forming a part of the lower section of each pair of telescopic tubes is a large air chamber which removes pulsations caused by the pumping action of the telescopic tubes. At the lower end of the reciprocating part of each tube are two leather cup washers, forming a piston and preventing leakage. The tube and air chamber assembly is supported on a strut between the "A" frames and at the upper end is fastened to the underside of the cylinder base with a gasket joint, thus preventing water leakage into the crank pit. Any water that may leak past the cup washers will discharge into the cylinder base and be conducted away through drains connected to the compartment un-

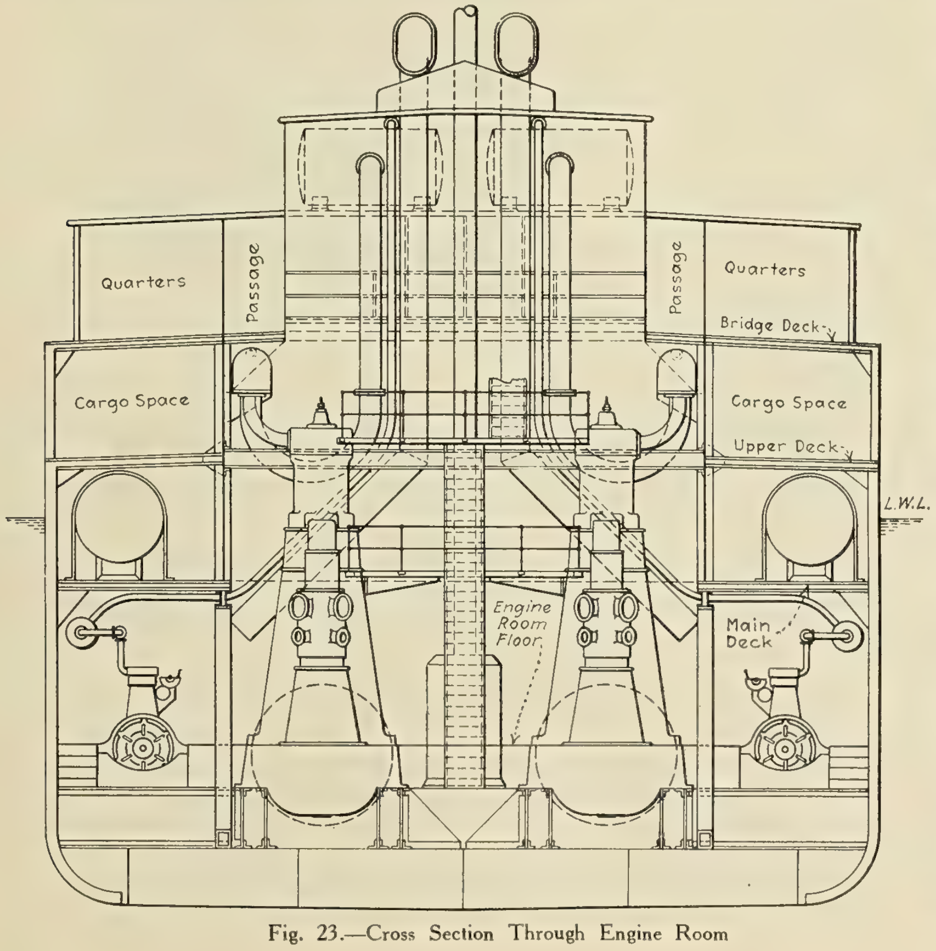


Fig. 23.—Cross Section Through Engine Room

der each power cylinder. At the point where the telescopic tubes pass through the cylinder base a closely fitting spash hood is proided that will prevent any drops of water being thrown up onto the cylinder wall or piston rod.

The piston cooling water return header runs the length of the engine on the outboard side. At the forward end of the engine it discharges into the engine room bilge. Discharge from each piston into the header is through a funnel. This enables the attendants to watch the flow from each piston and test the temperature by feel.

A 2-inch branch from the main cooling water inlet passes across the front of the engine and connects to the crosshead guide water inlet header which runs fore and aft on the inboard side of the engine. A branch to each guide conveys water into the cooling space, whence it rises to the top of the guides and flows out into the outlet header. This outlet header runs forward and crosses over to join the main cooling water outlet near the point where it leaves the third stage compressor jacket.

Lubricating Oil System. Forced oil feed is used for lubricating all of the principal bearings. A motor driven, independent pump draws the oil from a sump tank below the engine room floor and discharges it at 15 pounds pressure into a fore and aft 3-inch header on the outboard side of the engine at the level of the main bearing. Opposite each main bearing a branch pipe passes through the leg of the "A" frame and connects to a passage through the main bearing cap. From the bearing the oil passes into the axial hole in the crankshaft through radial holes in the shaft which register with a circumferential groove in the bearing. It passes from the axial hole in the shaft through a hole in the crank web into an axial hole in the crankpin. From this axial hole it is conveyed through radial holes to a circumferential groove in the crankpin bearing. An axial hole in the connecting rod allows the oil to flow up through the rod to the crosshead pin bearing and crosshead guide. From there the oil falls into the pit formed by the closed engine bed, each compartment of which is fitted with a drain hole, and drains into a 6-inch header and thence to the sump tank.

From the forward end of the oil inlet header a small branch supplies oil to the compressor bearings. A branch from the aft end supplies oil to the thrust bearing and steady bearings.

For reclaiming oil that has become contaminated by continuous use, a Richardson oil filter is provided. In this filter the oil is heated and the water settled out: then it is forced through muslin filters that remove any foreign matter held in suspension. The filter is arranged so that a part or all of the oil may be cleaned. Filtration may be carried on while the engine is in operation or while it is stopped.

Lubricating oil is supplied to the power cylinders, compressor cylinders and auxiliary exhaust valves by Richardson force feed lubricators placed on the "A" frames on the inboard side of the engine in a position easily accessible from the engine room floor, and operated by gears from the camshaft. Each power cylinder has two separate feeds placed diametrically opposite and timed so that oil enters on the suction stroke.

The camshaft bearings are fitted with chain oilers running in an oil bath. Other minor bearings are fitted with oil cups.

Exhaust System. The exhaust is conducted from the exhaust valve outlets through pipes, curved to provide for expansion, into a horizontal manifold at the rear of the engine. This manifold is in two sections, one for each group of three cylinders, connected by a curved pipe.

Simplified Apparatus for Indicating Percentage of CO_2 in Flue Gases

During the war a new type of carbon dioxide indicator was developed which eliminated many of the complications of the usual type flue gas analyzer or recorder. The saving of coal, although important during the war, is even more essential now when the fuel shortage has curtailed production in many industries. The new indicator which is being manufactured by the Chadburn Ship Telegraph Company of America, Inc., Troy, N. Y., maintains a continuous record of the operation of a boiler in much the same manner as the water level is shown by the water glass.

As a matter of fact, the indicator is similar in construction to the water level tube, but is calibrated in percentages of CO_2. Its operation consists in drawing gases

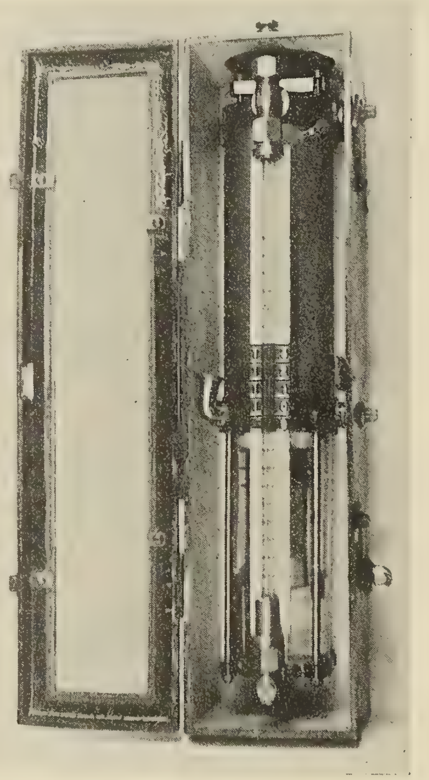


Fig. 1.—CO_2 Indicator

from the flue, which is under observation by means of a small steam-jet aspirator. The gas samples thus obtained are first drawn through a filter and into a chamber in which a porous pot containing a drying reagent is fitted. This chamber is connected through a small pipe to a vessel holding a quantity of water. Another pipe, one end of which is below the surface of the water, is led back to the porous pot. As the gas filters into the chamber, a certain volume penetrates the walls of the porous pot, where it is absorbed by the reagent, with the result that a partial vacuum is formed in the system, causing a colored liquid to be drawn into the indicating glass.

The indicator is fixed close to the boiler where it may be under the observation of the stoker at all times. If a low percentage of CO_2 is shown, the dampers of the boiler are opened. If the gage then registers still lower, it is apparent that too much air has been admitted, so the dampers are adjusted until the column indicates about 14 to 16 percent. Should anything happen to the fire the fact is instantly shown by the drop in the glass and the

trouble can be immediately corrected, so that it is possible to maintain proper combustion at all times.

Where forced or induced draft is in use, the steam injector may be dispensed with, although actually but little steam is required to operate the jet, the average steam consumption being about one pound per hour. The only

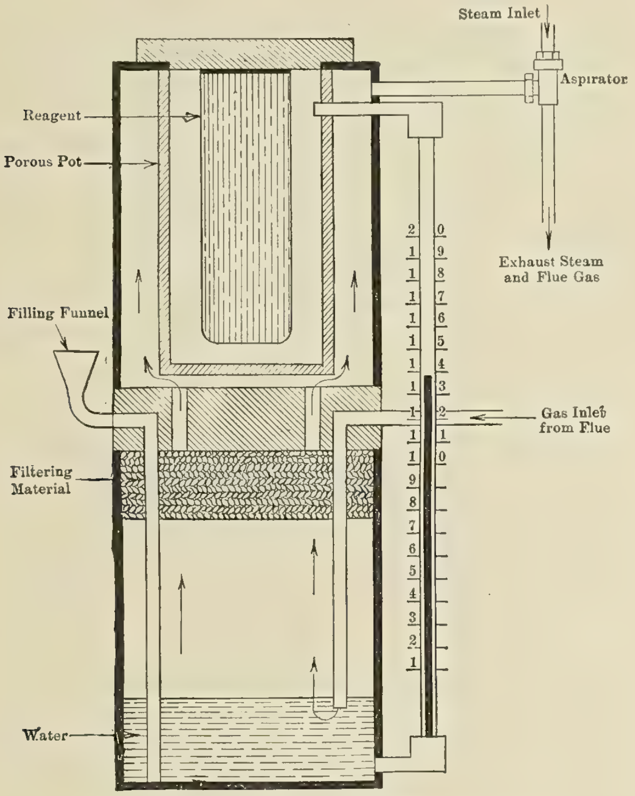


Fig. 2.—Diagrammatic Section Through Indicator

attention required in the maintenance of the instrument is the replacement of the drying reagent about once every forty-eight hours. As the chemicals are contained in a cartridge, which is readily placed in the proper position in the instrument, there is no danger of an inexperienced operator throwing out any adjustments.

In the operation of land and marine installations, where the equipment includes both automatic stokers and hand-fired boilers, the device has effected a minimum fuel saving of 10 percent. This saving in some cases has gone as high as 20 percent.

From the following table may be readily understood the possibilities of fuel conservation through the elimination of waste in the flue gases:

THEORETICAL PERCENTAGE OF FUEL WASTED IN EXIT GASES AT VARIOUS TEMPERATURES

Temperature of Exit Gases in Degrees F.	Percentage of CO_2 in Exit Gases											
	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%
100	8.1	6.5	5.4	4.7	4.1	3.7	3.3	3.0	2.8	2.6	2.4	2.3
200	16.2	13.1	10.9	9.4	8.3	7.4	6.7	6.1	5.7	5.3	4.9	4.6
300	24.3	19.6	16.4	14.2	12.5	11.2	10.1	9.2	8.5	7.9	7.4	6.9
400	32.4	26.2	21.8	18.9	16.4	14.9	13.4	12.3	11.4	10.6	9.8	9.2
500	40.5	32.7	27.3	23.6	20.8	18.6	16.8	15.4	14.2	13.2	12.3	11.6
600	48.6	39.3	32.8	28.3	24.9	22.3	20.2	18.5	17.1	15.9	14.8	13.9
700	56.7	45.8	38.2	33.1	29.1	26.0	23.5	21.6	19.9	18.5	17.2	16.2
800	64.8	52.4	43.7	37.8	33.2	29.7	26.9	24.7	22.8	21.2	19.7	18.5

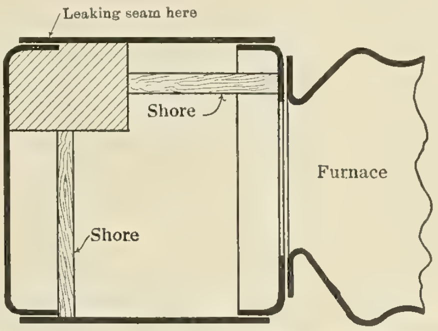
In many boiler plants the percentage of CO_2 in the waste gases is as low as 6 percent. For example, where the record is at this figure with a gas exhaust temperature of 500 degrees F., a saving of 13 percent in the fuel consumption may be effected if the CO_2 is increased to 12 percent.

Novel Method of Stopping Leak in Combustion Chamber

BY W. S. ESPLIN

ON a twin screw vessel about four years old, which was equipped with five single ended boilers working under forced draft at a steam pressure of 205 pounds per square inch, boiler troubles were practically non-existant with the exception of some persistent leaks at the three ply joints of the combustion chambers. Time and time again several rivets were removed and renewed at the affected parts with more or less success in overcoming the difficulty. The chief difficulty encountered, however, when renewing these rivets was the inaccessibility of the position in the boiler and the narrow space existing between the combustion chambers, which made efficient holding up while riveting almost impossible and calking out of the question.

In one of the boilers, just prior to leaving Brooklyn, the center back end was re-riveted and calked at the affected part, but on the short run to Boston the trouble broke out afresh. Eventually this was entirely settled by having these seams treated by electric welding, but before this was done the defect was temporarily overcome by using a solution of Smooth-on applied as shown in sketch.



Sketch of Firebox, Showing Method of Holding Cement in Place

The box used was an ordinary well-made butter box measuring 15 inches by 12 inches by 12 inches. The lid and two sides having been removed, the box was put in position and scribed from the plates, so that when cut to the marks only a small amount of putty jointing was necessary to make it watertight. It was then shored in position (the boiler being empty) and filled with the Smooth-on mixture of a consistency similar to milk. About twelve hours was allowed for the solution to act, during which time one of the fireroom hands occasionally stirred the liquid to prevent undue settling.

Before closing up the boiler finally an examination of the rivet heads and seam of the defective joint inside the boiler showed evidence of a faint trace of the liquid oozing through; the boiler was then closed, filled and put into commission in due course. The result was entirely satisfactory, and no further trouble was experienced.

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WE GUARANTEE that of this issue 9,150 copies were printed; that of these 9,150 copies 7,656 were mailed to regular paid subscribers, 450 were provided for counter and news company sales, 308 were mailed to advertisers, 57 were mailed to employes and correspondents, and 679 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 80,500—an average of 10,063 copies a month.

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The Leviathan

IT is to be regretted that only one concern, the United States Mail Steamship Company, submitted a bid for the *Leviathan*, and also that the amount offered for this magnificent vessel was only $3,000,000, with the conditions that the United States lend the steamship company $6,000,000 to repair the vessel and provide a berthing pier while the repairs were being done.

While it would cost in the neighborhood of $25,000,000 to reproduce the *Leviathan*, it is not probable that any company, either here or abroad, would attempt to build a vessel of this size under present conditions. It has been found very difficult to operate these large vessels on a paying basis, and, according to one of our English contemporaries, the experience which the Cunard Company has had with the *Imperator* has been by no means a particularly happy one.

The British, however, have not wasted any time in reconditioning their large vessels, and in the cases of the *Olympic* and *Aquitania* they have shown their progressive spirit by installing, at a prodigious cost, oil burning equipment in place of the coal furnaces. The return of the *Olympic* to the North Atlantic service was made the occasion for a special excursion, which was enjoyed by many notable people. Mr. Harold Sanderson, chairman of the Oceanic Steam Navigation Company, delivered a speech at a banquet held aboard the boat in which he referred to the *Olympic* as "the one ewe lamb" of their fleet. He dwelt at length on the cost of producing these great ships at the present time and held out no hope whatever that the Oceanic Steamship Company would build another *Olympic* for a long time to come.

At a recent luncheon, Admiral Benson stated that he was inclined to believe that it would be a good policy for the Government to accept the offer of the United States Mail Steamship Company. However, the Shipping Board probably will not render a decision on this bid until President Wilson has appointed a few at least of the seven members that constitute that Board under the provisions of the Merchant Marine Act. Considering the facts that it will cost between $8,000,000 and $10,000,000 to recondition the *Leviathan*, that the vessel is deteriorating perhaps more rapidly at her berth on the North river, where the water is known to be bad, than she would be in active service, that it is costing the Government a considerable sum each day that she remains in her present state, and that it is desirable to get her on an established run while the passenger traffic is good, it would appear that Admiral Benson is placed in a position that requires his most unbiased judgment.

The fact that the United States Mail Steamship Company was the only concern that had the enterprise to bid on this ship is not encouraging, but it is clear that the vessel cannot be allowed to remain idle. "We would fain suggest that the *Leviathan* is proving a white elephant to the United States," says an English paper. On this side of the Atlantic the most of us would fain see the *Leviathan* doing her bit toward establishing our merchant marine, even if it is necessary to dispose of her at what seems to be a low figure.

Forced Lubrication for Reciprocating Engines

WHILE so much time and money are being spent in designing and perfecting new types of marine machinery, would it not be a good idea to make every effort to perfect still further the machinery we now have installed and bring it up to a standard of reliability comparable with our newer installations? Some years ago it was thought that the reciprocating engine had been developed to the highest possible point of efficiency. To improve the economy of future installations it was thought necessary to turn either to turbines with reduction gears or to electric drive. But in spite of this we continued to build vessels with reciprocating engines, and there is no reason why they should not be equipped with any improvements that have been developed in the meantime. Moreover, those already in service, when their condition warrants it, should be brought up to the highest point of efficiency in order that the return on the investment may be as large as possible.

One direction in which a distinct improvement can be made is in the adoption of forced lubrication, as outlined elsewhere in this issue. While the exact cost of installing a forced lubrication system cannot be given, as it will vary with each type of vessel, it is believed that the improvement would pay for itself in a comparatively short time when the saving in oil, repair bills and delays caused by renewal of bearings is taken into consideration. If we are to expect the same reliability from our vessels equipped with reciprocating engines that we expect from our vessels equipped with geared turbines, we should install as satisfactory a lubricating system in them as we have today in our geared turbine installations. The same re-

liability and small bills for repairs can then be expected, and no doubt obtained, by the installation of a satisfactory forced lubrication system with the reciprocating engines.

The Seamen's Act

THE penalty for desertion as outlined in the Seamen's Act provides that a sailor shall forfeit all or part of the clothes and effects that he leaves on board and all or any part of the wages that he has earned. This is not sufficient to prevent many sailors from abandoning their vessels in foreign ports, especially as they may demand half of the wages that are due them upon arrival. It certainly would not help the morale of a crew to deprive them of their shore leave or spending money, and to do so would work an injustice on the innocent, but it is evident that some means should be taken to prevent men who have no respect for a contract from leaving their vessels without cause in a foreign port. Is it not a fact, however, that this one weakness has prejudiced a great many of us against an act that is beneficial rather than detrimental to the development of our merchant marine?

Although much criticism has been expressed in regard to the privileges allowed American seamen under the Act of March 4, 1915, it is a fact that we cannot hope to induce American citizens to follow the sea unless we provide decent quarters and living conditions for them. Our most successful industries on shore pay particular attention to making their plants attractive, in spite of the fact that the number of men required to operate a manufacturing plant is far in excess of the number of sailors required to operate a ship. The provision that the quarters shall be so designed that each man will have at least 120 cubic feet of air space and 16 square feet of floor space is anything but excessive. Some of our cities have laws requiring at least 400 cubic feet of air space per man in their cheap lodging houses. The Norwegians have a law which provides that not more than four men shall be quartered in one room aboard ship, and it has been found that the men prefer this arrangement to the open forecastle. Such restrictions as that there shall be a separate berth for each seaman, that not more than one berth shall be placed above another, that the quarters shall be properly lighted, drained, heated, ventilated and protected as far as possible from the sea and from the gases from the bilge ought to be a matter of course and common sense, as is also the provision that ocean-going vessels which carry a crew of twelve or more men shall have a space set apart as a hospital, that there shall be at least one light, clean and properly ventilated washing place with at least one washing outfit for every two men on watch, and that there shall be a separate washing place for the engine and fireroom crew.

The above is the substance of the requirements that are necessary for the quarters. The size of the crew is specified as such that will allow a division of the sailors into at least two watches and the engine and fireroom force into three. The wages and subsistence items of the crew of a steamer are but a small percentage of the operating costs, and the wages of the few additional men required by this act (generally three or four) on American vessels does not constitute an item that would determine the successful operation of any ship. In fact, the higher wages of American seamen, which has nothing to do with the Seamen's Act, does not prevent the successful competition of American with foreign vessels. The Shipping Board has pointed out that the expenses of the crew of a steamer never constitutes more than 12 percent of the operating costs.

Passenger Vessels

TOO much emphasis cannot be placed upon the fact that our merchant marine is badly handicapped by a lack of passenger, fast freight and mail steamers. Our ships were constructed to supply the needs of a great emergency and, consequently, the bulk of these vessels are freighters. Every trade route that is not supplemented with a direct American passenger service must do business through foreign channels which will, of course, favor their own enterprises in so far as it is possible for them to do so.

If we are to secure our share of the trade of the great continents of Africa, South America and Asia, it is essential that our invoices, bills of lading, mail, and business men shall have direct intercourse with these countries through up-to-date and modern American passenger vessels, because it is only through such service that reasonably prompt deliveries can be assured at both ends and that the present serious obstacles to trade development can be removed. In the case of Africa, it is now necessary for passengers and mail to go by the way of England, from which country Africa enjoys excellent fast liner service. This means that bills of lading and invoices often arrive fifteen or twenty days after the goods they should accompany, with the result that deliveries are delayed and excess charges assessed.

Many lines are needed to provide regular and frequent service to the east and west coast of South America. It is an open secret that the people of South America are beginning to wonder if the United States intends to let its merchant marine drift back to the pre-war status. The superiority of the steamship service between Europe and South America over that between the United States and that country is very marked, and we are jeopardizing a splendid opportunity to establish closer and more cordial relations with the business men of South America by delaying the construction of suitable liners to cover properly the necessary routes. If the right kind of liner service is provided to back up the freighters that are now built, the trade between the United States and South America will quickly assume and maintain proportions and permanency that will insure our greatly expanded industries a market for their surplus production. The construction of our merchant marine was largely an act of patriotism; its maintenance and development should prove a profitable investment and is a necessity if our industries are to be kept at capacity production.

LETTERS TO THE EDITOR

Opinions Wanted Regarding Fiber Packing for Condensers

I would appreciate any expressions of opinion I could obtain in regard to experience anyone has had with fiber packing for condensers for marine purposes, and if, in their opinion, fiber packing can be applied in stuffing boxes where the thread is cut to the bottom of the packing box.

Also, what is the best solution to use with corset lacing, Albany grease or linseed oil?

Harriman, Pa. W. T. WILSON, Works Manager,
Merchant Shipbuilding Corporation.

Gravity Type Filters in Geared Turbine Lubricating Systems

In the June, 1920, issue of MARINE ENGINEERING I have read with interest an article by Messrs. Schmeltzer and Fernald on the subject of "Lubricating System for Geared Turbines."

I wish to direct attention to a gross and probably inadvertent misstatement which is made on page 510 in the paragraph entitled "Filters and Separators." In this paragraph mention is made of the fact that the centrifugal type of purifier is preferable because in the gravity filter the filtering elements, when placed in the gravity tank, will not function properly unless a sufficient head of oil can be obtained. Furthermore, due to the lack of this head, the oil will follow the line of least resistance and overflow without being filtered.

The Richardson-Phenix Company, Milwaukee, Wis., has furnished between 700 and 800 gravity type of filters for vessels, and of this number approximately 300 were used in connection with geared turbine lubricating systems.

The principle of the R-P type of filter is such that the oil is caused to pass through the filtering medium, which is cloth in a vertical position, at a very low head, ranging from 2 inches to 12 inches. This head is obtained in the filter tank itself and is not dependent in any way whatsoever upon the outside piping or the balance of the system. Furthermore, a high head is quite undesirable because of the fact that forcing oil through the filtering medium under a greater pressure than that obtained from an average of, say, 4 inches will cause the very fine particles of dirt and foreign matter to be forced through the filtering medium along with the oil, thus lowering the efficiency of the filter.

Messrs. Schmeltzer and Fernald in their article entirely omit mentioning the difficulties which have been encountered with the mechanical or centrifugal type of oil filter. The multiplicity of parts moving at such a high rate of speed almost require an oiling system in themselves to keep the purifier in operation. Then, again, the problem of cleaning the gravity type of filter, which has no moving parts, as against cleaning the bowl of a centrifugal oil purifier is such a simple proposition that it is preferred by marine engineers, who demand something which will accomplish the desired results, that is, restore the oil to its original lubricating value with the least number of complications.

In justice to the experiences which the writer, as well as other engineers who have installed gravity oil filters, have had in this line, we believe that the information above should be given due publicity in your valued journal.

New York. EDWIN M. MAY, District Manager,
The Richardson-Phenix Company.

United States Battleships of the Year 1914 and Later Classes*

The editorial in the May issue of MARINE ENGINEERING, entitled "Two Years of Electric Propulsion on the *New Mexico*," is of vital concern to everyone connected with large naval vessels and interested in the important question as to the most suitable type of propelling machinery.

It is, however, with some hesitation that I take up my pen and make replies to many of the statements, owing to the fact that the data given are copied from a report submitted by my good friend, Commander S. M. Robinson, fleet engineer of the Pacific Fleet, and comments are bound to seem somewhat presumptuous in view of the first hand information that was available to the author.

The remarks dealing with the maneuvering qualities of the *New Mexico* are of special interest, and my experience has shown that most turbine ships are also capable of turning completely round without gaining ground, either ahead or astern. The Cunard liners *Mauretania* and *Lusitania* have done this stunt regularly in New York Harbor, off the Quarantine Station.

I note that it is customary with this ship when maneuvering either in restricted or in dangerous waters to use only one turbo-generator and that this combination has shown the more satisfactory method of operation. It seems to me that this shows it is not necessary or desirable to use equivalent to full ahead power when backing, and justifies the arguments of the turbine builders who have always felt that 50 to 60 percent backing power was ample for all requirements, whereas the electric drive enthusiasts have repeatedly advocated the necessity or desirability of having "full power" astern.

The three battleships *New Mexico, Mississippi* and *Idaho* are sister ships in every sense as regards proportions of the vessels, but the designs of the propelling machinery are so different in each case that it is almost impossible to make comparisons of performance that can be considered fair or just.

Each ship is driven by four propeller wheels and has a designed sea speed of 21 knots, but the revolutions differ:

(No. 40) *New Mexico,* 175 revolutions per minute; (No. 41) *Mississippi,* 240 revolutions per minute; (No. 42) *Idaho,* 240 revolutions per minute.

This feature alone gives the *New Mexico* a great advantage over her so-called sister ships, inasmuch as the slower revolutions make more efficient propellers.

In addition, the *New Mexico* is the only one that has carried out complete sets of speed and oil fuel consumption trials under the supervision of the Board of Inspection and Survey. This makes it possible to use the data so obtained on these tests and compute comparisons with the less fortunate vessels, so that comparative performances will always show up favorably in the vessel which was fully tested out by reliable trials. The *New Mexico* did, however, carry out two sets of trials, the first proving very unsatisfactory.

In view of the fact that the art of propelling vessels by direct driven and geared steam turbines has progressed

* *References:*
"U. S. S. *North Dakota,*" Journal of the American Society Naval Engineers, Vol. 22, 1910.
"U. S. S. *Florida,*" Journal of the American Society Naval Engineers, Vol. 24, 1917.
"U. S. S. *Wyoming,*" Journal of the American Society Naval Engineers, Vol. 24, 1917.
"U. S. S. *Jupiter,*" Journal of the American Society Naval Engineers, Vols. 24, 25, 26, 1912-13-14.
"U. S. S. *Wadsworth,*" Journal of the American Society Naval Engineers, Vol. 27, 1915.
"U. S. S. *Conyngham,*" Journal of the American Society Naval Engineers, Vol. 28, 1916.
"U. S. S. *New Mexico,*" Journal of the American Society Naval Engineers, Vol. 31, 1919.

to a remarkable extent during the last ten years, it is only right that the subject of the machinery for these vessels should be examined, not so much from the point of view of results in service, but to ascertain just why such machinery installations were built for the *Idaho* and *Mississippi*, which apparently compare so unfavorably with the *New Mexico*. This can best be done by referring to the bids which the various shipbuilders offered to the Navy Department in Washington on October 6, 1914. Four shipbuilding firms submitted proposals, but I shall only refer to those submitted by the successful contractors. Of these three ships, one was required to be built in a Navy Yard.

The New York Shipbuilding Corporation made three proposals, the lowest in price having Parsons geared turbines, while the bid accepted by the Navy Department has direct driven turbines costing $75,000 more than the former, and this firm was awarded a contract to build the *Idaho*.

The Newport News Shipbuilding and Dry Dock Company made three proposals, all of which had direct driven turbine machinery, and this firm built the *Mississippi*, having the Brown-Curtis type of direct drive turbine.

In 1915, battleships Nos. 43 and 44 (the *Tennessee* and *California*) were authorized to be built at Navy Yards, so no public bids were called for in these cases, and both of these ships are fitted with electric propelling machinery.

Battleships Nos. 45 to 48 were ordered in 1916 and bids were opened in Washington on October 25. Two of these ships are building at each of the following shipyards: New York Shipbuilding Corporation and Newport News Shipbuilding and Dry Dock Company. All have electric propelling machinery, which is being supplied by the Navy Department, the contractors for the vessels not being in any way responsible for satisfactory operation. Both of these firms submitted splendid propositions with geared turbines, but they were rejected.

The foregoing clearly shows that the shipbuilders fully realized the possibilities of mechanical reduction gears, and a geared turbine installation in the battleship *Idaho* would have made a reliable and accurate comparison with the *New Mexico*.

The various bids received for building destroyers also show that the shipbuilders had clearly recognized the great advantages of geared turbines.

Destroyers Nos. 57 to 62 were ordered in 1913, and the Bath Iron Works, Ltd., was awarded a contract for one vessel with two sets of Parsons geared turbines. This was the *Wadsworth*, No. 60. The other five have direct driven turbines and geared cruising units.

Destroyers Nos. 63 to 68 were ordered in 1914, and the Navy Department plans and specifications especially called for geared turbines. Various bids were received for vessels of this type, but all were finally contracted for with direct driven turbines.

Early in 1915 the destroyer *Wadsworth* completed her preliminary acceptance trials, breaking all known records of fuel consumption at every speed for vessels of this type, and it was only at this time that the Navy Department began to appreciate and realize the importance of geared turbine machinery.

Destroyers Nos. 69 to 74 were ordered in the fall of 1915, and in this case the Navy Department plans called for direct driven turbines, but only two were built to the Department plans, having 3-shaft turbines, the other four having twin sets of geared turbines. Of the four vessels having gears, only one has had any gearing trouble, No. 69, the *Caldwell*, the machinery for which was built by the General Electric Company, Schenectady, N. Y.

In October, 1916, destroyers Nos. 75 to 94 were ordered. All have twin screws driven by geared steam turbines.

Again, the great fleet of destroyers contracted for during the war, Nos. 95 to 347, have twin sets of geared turbines, and the general arrangement of the machinery in all these vessels closely resembles the original machinery installation of the pioneer geared turbine destroyer *Wadsworth*.

One of the great advantages claimed for electric drive was that this type of machinery would not be subjected to breakdowns, necessitating Navy Yard repairs. There are only two such vessels, the collier *Jupiter* and the battleship *New Mexico*, at sea, and both have developed mechanical defects. The *Jupiter* stripped blading during one of the first series of trials off the Pacific Coast. As stated in the report, the *New Mexico* also had what was undoubtedly a serious accident, for it necessitated installing a new rotor in one turbo-generator and a thorough overhaul of the armature. While both of these accidents may not have had anything to do with the system of propulsion in use, yet it does show that such machinery is not necessarily immune from accident.

Practically nothing is said about high speed condition of these three battleships, except that the *New Mexico* is rated between 21 and 22 knots. Her actual speed is a little over 21 knots, and all full speed runs have shown this vessel to be the slowest of the trio. In high speed runs the *Idaho* always maintains the lead, followed by the *Mississippi*, while trailing astern comes the *New Mexico*. In view of the fact that her motors can develop 37,000 shaft horsepower, this feature is not altogether reassuring, but differences of this sort can generally be explained satisfactorily by pointing to the boiler room equipments.

The statement which infers that the direct driven turbine destroyers having geared cruising units compare favorably in fuel consumption with all-geared turbine destroyers is difficult to understand, as an up-to-date all-geared turbine battleship with Parsons machinery will show great gains in fuel economy over the direct driven turbines and geared cruising units. To justify my remarks, I herewith give average representative figures of "oil fuel consumption in pounds per knot run" for some of the Parsons turbine driven destroyers:

Twin Screw Direct Driven Parsons Turbines with One Geared Cruising Unit

Knots	(No. 58) *Conyngham* (No. 59) *Porter* (No. 67) *Wilkes*	(No. 61) *Wainwright*
12	130	157
16	144	176
20	182	217
25	380	390
29.50	562	640

Twin Screw All Geared Parsons Turbines

Knots	(No. 60) *Wadsworth*	Nos. 75 to 78 Nos. 113 to 118 Nos. 125 to 130
12	116.50	100 to 130
16	129.50	138 to 150
20	152.50	180 to 200
25	275	264 to 320
30	473	433 to 480
35	......	623 to 686

The foregoing figures speak for themselves. They do not take into account that the displacement of the all-geared boats (except the *Wadsworth*) is much greater than the direct driven vessels. Again, at full power in excess of 35 knots, and at the cruising speed of 25 knots in the case of the all-geared ships, the fuel consumption varies between .875 pound to .95 pound of oil fuel per

shaft horsepower for all purposes, and these results have been attained in a large number of these vessels.

With reference to the direct driven turbine battleships, it should not be overlooked or forgotten that the performance of these ships has been excellent. The *Florida* still holds the full speed record for any American battleship, namely, 22.08 knots for four hours, made during the official acceptance trials in 1912, while the record of the *Wyoming*, as regards freedom from accident and reliability of machinery, has never been approached by any other vessel of her class.

The only all-geared turbine installation in any American battleship has been fitted recently in the *North Dakota*, and this has been an unqualified success. The original machinery consisted of twin sets of direct driven Curtis turbines, now replaced by Parsons geared turbines, built in the New York Navy Yard, Brooklyn, N. Y.

To really appreciate the great strides "the all-geared turbine" has made during the last six years in warships, I strongly advise engineers and naval architects to read the following papers which were presented before The Institution of Naval Architects, London, at the recent annual meetings:

"H. M. S. *Hood*," by Sir Eustace D'Eyncourt, K. C. B., vice-president,

"Experience and Practice in Mechanical Reduction Gears in Warships," by Engineer-Commander H. B. Tostevin, D. S. O., R. N.

I cannot understand just why Mr. Robinson has attempted to make comparisons between the *New Mexico* and the so-called sister ships. The cruising arrangements of the two turbine driven ships are so radically different that comparisons which are to be of any value should be made according to the results obtained with each ship. The *Mississippi* can use the cruising turbines only up to 15 knots, about one-fourth maximum power, while the *Idaho* can cruise up to 17 knots, about two-fifths maximum power; therefore, it stands to reason that these vessels cannot be compared on equal terms with a third vessel.

I fully realize that the economy of the *New Mexico* machinery is bound to be very good, if the vessel is driven entirely by one turbo-generator, the other, with its auxiliaries, being shut down. This, however, cannot in any way be considered as the regular way in which the machinery is being operated, and when she is a unit in a division, doing drill and battle practice, it will be essential that the other generator and its auxiliaries are turning over idly. It is only on a long sea cruise that one turbo-generator can really be used to advantage, *and only in peace times.* There is absolutely no military advantage gained in operating capital warships under such conditions, and while this gives a very easy time for the engine room personnel, *yet it would never be done during a war in the open seas.*

In conclusion, I fully appreciate the difficulties before one who attempts to make comparisons between a modern electrical driven battleship with its slow turning propeller wheels and direct driven turbines having fast turning propellers, and I have little hesitation in saying that any such comparisons should be used with the utmost caution.

New York. Ernest H. B. Anderson,
Parsons Marine Steam Turbine Company.

Oil Fuel Proves Economical.—The Norwegian American liner *Bergensfjord*, recently converted to an oil burner, made her initial voyage from Christiania to New York at a speed of about 17 knots as compared with her former record of 15 knots as a coal burner. About 1,250 tons of fuel oil were consumed on the voyage and twenty-five less firemen were required to operate the vessel.

NEW BOOKS

The New Merchant Marine

The New Merchant Marine. By Edward N. Hurley, formerly chairman of the United States Shipping Board. Size, 5½ by 8 inches. Pages, 296. Illustrations, 8. New York, 1920: The Century Company. Price, $3.

This book is primarily a report to the American people on the construction, operation and the necessity for the permanent development of our new merchant marine. By report, I do not mean a mass of statistics, but rather an interesting and easily followed narration of the stupendous work accomplished by the Shipping Board and the value of the merchant marine to the prosperity of our country and to the world.

Starting with a description of our merchant marine in the early days, in which the growth and subsequent disappearance of our ships from the seven seas are explained, Mr. Hurley shows how difficult it would have been in the ordinary course of events for our country to return to its heritage on the seas.

The organization, preparations and problems of the Shipping Board are then dealt with and the enormous work which was accomplished in the building and fabrication of our new merchant marine is visualized insofar as it is possible to do so with words.

Passing from the construction of the merchant marine to operation, a subject which to most of us is both fascinating and mysterious, Mr. Hurley explains in detail from his experience as the former head of the largest shipping organization in the world the problems that have to do with ship operation. After reading this book the most skeptical should be convinced that the higher wages and better treatment of our sailors are not an appreciable percentage of the operating costs. The greatest value of this book, however, lies in the clear explanation of the trade routes that should be developed, the necessity for passenger lines, particularly between this country and South America and Asia, and the necessity for American insurance for American ships and cargoes. If Mr. Hurley's work could be read by the majority of our countrymen, the future of our merchant marine would be assured.

Diesel Engine Design

REVIEWED BY C. H. PEABODY, DR. ENG.

Diesel Engine Design. By H. F. P. Purday, B. Sc. Size, 5½ by 8½ inches. Pages, 302. Illustrations, 271. New York, 1920: D. Van Nostrand Company. Price, $7.50.

The Diesel engine is only a quarter of a century old, but it is now thoroughly established and its characteristics and limitations are as well known as those of the steam engine. The author of this work has been a designer of Diesel engines for half that time and is familiar with the general principle and the details of construction; the latter are given with particularity, and on them the proper working of the engine depends more than for any other heat engine. The author is writing for designers and passes lightly over such matters as are familiar to designers. In places a somewhat more extensive presentation would be desirable for the general reader.

The book is limited to the standard type of the Diesel engine and leaves aside not only the hot bulb engine (sometimes called the semi-Diesel engine), but also engines which work on the Diesel cycle but with mechanical ignition of the fuel.

The essential Diesel principles are:

(1) Compression sufficient to produce the temperature

requisite for spontaneous combustion of the fuel.

(2) Injection of fuel by a blast of compressed air.

(3) A maximum cycle pressure not greatly exceeding the compression pressure, i. e., absence of a pronounced explosive effect.

We may have in mind that the pressure requisite is 500 to 550 pounds for the four-stroke engine and may be 600 for the two-stroke engine. The temperature corresponding is about 1,200 degrees F. The air blast supplies one-twelfth of the air for combustion.

In the thermodynamic discussion the author assumes that the rate of fuel injection is so regulated that the pressure remains constant, and that the expansion curve has the exponent 1.35, which indicates the existence of after-burning. In practice the pressure is likely to rise during fuel injection. The excess of pressure above that by compression is controlled to avoid excessive temperatures and excessive after-burning. The author computes the efficiency of an ideal diagram with a flat top as 0.57 and states that a splendid actual efficiency is 0.35, so that the ratio is 0.82, from which he draws the conclusion that the margin for improvement is very narrow. Now the thermodynamic theory of the internal combustion engine is difficult and unsatisfactory and the ratio just stated may be accepted with considerable reserve. It has a substantial advantage in that it emphasizes the fact that the Diesel engine has arrived at its complete development and that improvements, if they can be found, will be in minor details. The Diesel engine had the advantage at its inception that engineers were already equipped with sufficient knowledge and shops with requisite machinery so that perfection was approached rapidly, whereas the steam engine required a century to build up the metallurgical and engineering industries needed for its perfection.

The author gives as a typical heat balance: Work, 42 percent; cooling water, 34 percent, and exhaust, 24 percent. This is a good showing; it is immaterial whether rejected heat goes to cooling water or to exhaust. Following a fashion that has somewhat gone by, the author discusses the entropy chart of the cycle. Some engineers are of the opinion that entropy, which was invented for the discussion of the steam engine, may well be limited to that engine and that other diagrams must be treated with great discretion, if errors are to be avoided.

As an introduction to design, the author gives the principles of similitude and computes special tables for the use of that method. The principles are similar to those for steam engines and he finds that similar engines have the power proportional to the square of diameter while the weight is proportional to the cube, as is the case for steam engines. As is well known, this militates against the unlimited growth of engines; the case is harder for internal combustion engines because steam boilers are not subject to this law, and for various reasons both mean effective pressure and piston speed are reduced for large sizes of internal combustion engines. The steam engine has escaped from this restriction by changing into steam turbines, but the Diesel engine, despite the efforts of competent engineers for nearly a quarter of a century, remains a small power engine. Experimental engines developing a thousand horsepower in one cylinder have been constructed, but at sea, where the Diesel engine finds its most promising field, three hundred horsepower per cylinder is near the limit in practice. However, with six or eight cylinders to an engine, twin screw installations can take care of the bulk of freight and a good deal of passenger service.

With the high pressures and temperatures of the Diesel engine, lubrication is of prime importance. Two conditions arise according as the engine has a trunk piston or a crosshead; the latter type demands forced lubrication for all but small engines, and the largest powers require the oil to be cooled.

The crankshaft for engines with three or more cylinders may have a natural balance, but the eccentricity of individual cranks in any case will bring binding moments at the bearings, and even slight bending increases friction and wear of the bearings. Where possible, it is desirable to counterweight each crank, the only difficulty being to find space.

The author goes at some length into computation of stresses, in the pistons, crossheads (when used), connecting rods and crankshafts, including inertia forces; he is content to use either approximations or graphical methods, although exact results may be easily had if acceleration tables are provided similar to those used for steam engines. His treatment of torsional oscillation of the crankshaft and methods of avoiding that evil are excellent.

Flywheels are very important even for engines with multiple cylinders, especially for four-stroke cycles. This feature is the more important as the governor controls the fuel supply and there is considerable lag due to the fuel already beyond the governor's control. There are various modifications of control by the governor; perhaps the simplest is the provision of a plunger under control of the governor which holds the suction valve of the fuel pump off its seat for a period that decreases with the demand for power. The effect is the same as the use of a by-pass to reduce the delivery of a constant stroke pump.

The lubrication of the main bearings gives less trouble than might be expected considering the high initial pressure. The author calls attention to the fact that the pressure is momentary and time is required to break down an oil film. He says that for a peripheral speed of 550 feet per second ring lubrication is sufficient; when the speed is 750 feet per second forced lubrication is called for, and at higher speeds the oil must be cooled. The lubrication of the piston requires not so much a large supply of oil as even distribution, for which reason oil is supplied at six or eight circumferential points.

Many of the items rehearsed are interesting, as they show differences from steam engine practice and the requirement of judiciously arranged details. Unexpected points come up; in the author's opinion the best way of providing for small parts not readily water cooled is to connect them metallically with larger masses which are water cooled. This arises in discussing webbing of cylinder heads. Again he calls attention to the tapering of trunk pistons at the top where the temperature is high and expansion is large. His figures of connecting rods show forms substantially like those for marine steam engines at the big end; the little ends are commonly worked out of solid blocks on the rod on account of lack of space. Another curious feature is cross-bending of the connecting rod on account of friction at the crank pin when lubrication is accidentally insufficient.

Various arrangements of fuel injection valves are shown together with provision for control by the governor. Some are very ingenious. The governor must have considerable power, as it acts directly or indirectly on the valves. Like the valves for all internal combustion engines, these are operated by cam and must be loaded with springs that are capable of dealing with inertia forces of valves and levers as well as friction and pressure. It is rather curious that the author in his discussion of accelerating forces for valves uses the Newtonian notation instead of the usual forms for the differential coefficients.

We are all familiar with the noise made by internal

combustion engines which are insufficiently muffled at the exhaust. It will be novel to some that marine Diesel engines have silencing devices on the air suction. Land engines are very thoroughly muffled—sometimes with iron mufflers six times as large as a cylinder, sometimes having large concrete chambers twenty to thirty times the size of a cylinder. A moderate-sized muffler may answer, if the exhaust enters it through a trumpet-shaped diffuser.

Since the use of main blast for pulverizing the oil requires a considerable volume of air at 900 to 1,000 pounds per square inch, the arrangement of the air compressor and its system must be thoroughly worked out. Two or even three stage compressors are used with various drives—sometimes from the crankshaft, sometimes from a crosshead through levers, and sometimes by separate motors. The conditions and methods of design are not very different from compressed air work in general.

The author finishes with a chapter on valve gears which have the characteristics of cam gears, as used for all internal combustion engines. Marine Diesel engine valve gears have some complication in order to provide for maneuvering and reversing the engine. This may be realized from the author's summary of requirements for such gears:

(1) When the engine is standing the blast air should be cut off.
(2) The blast air should be turned on immediately when the engine starts.
(3) When the engine is standing the starting air should be turned off.
(4) The fuel pump suction valves should be held off their seats until the fuel valves are in running position.
(5) The fuel valve should be a handle with wide range of movement between no oil and full oil.
(6) A wheel or lever is provided with suitable mechanism for putting the starting valves into action, subsequently for putting them out of action when the engine gets under way.
(7) Some type of interlocking gear is usually fitted to prevent false moves.

Marine Boiler Management and Construction

REVIEWED BY C. H. PEABODY, DR. ENG.

Marine Boiler Management and Construction. Fifth edition. By C. E. Stromeyer, M. I. C. E. Size, 5½ by 8½ inches. Pages, 437. Illustrations, 466. New York, 1919: Longmans, Green & Company. Price, $5.

This is the fifth edition of a well-known work on boilers as used at sea; the first edition was published in 1893 and the book might be considered a classic were it not so very much alive in this present edition.

The most notable feature in which it differs from the fourth edition is the final chapter, giving the findings of the British Marine Engineering and Design Committee, in anticipation of the adoption of their report by the various authorities that appointed the committee. It is needless to say that the rules and methods recommended by the committee are eminently practical and useful; this chapter alone makes the book a distinct advance. The book also gives the most recent Lloyd's rules and British Board of Trade rules for boilers.

The book opens with directions for boiler management, especially for Scotch boilers, and has chapters on properties of steam, on corrosion, on fuels and combustion and on heat transmission. These are proper for any book on boilers, whether for land or sea service. It is to be noted that the tables for steam are taken from Regnault and Rankine; but for boilers almost any steam tables are sufficient.

The discussion of strength of boiler materials is very much to the purpose because of the peculiarities of service; the chapter on mechanics may perhaps be justified on the same basis. If there is any criticism of the chapters on construction and design, it may be directed to an exclusive consideration of the Scotch boiler, which is indeed the standard for merchant practice, but is now threatened by the watertube boiler. In the chapter on steam pipes the most recent methods of construction by electric and acetylene welding are considered, as well as the older standard methods.

An Exporter's Reference Guide

Exporter's Gazetteer of Foreign Markets, 1920-1921. Compiled and edited by Lloyd R. Morris, research editor, The American Exporter. Size, 5¾ by 8¾ inches. Pages, 808. Illustrations, 36 maps and 7 charts. New York, 1920: Johnston Export Publishing Company. Price, $10.

Published for the use of manufacturers, exporters, bankers, shipping and allied interests, this book gives a condensed survey of the world's markets and industries. A unique feature of the arrangement of the work is that all the commercial and industrial statistics and weights and measures have been converted into dollars and into American measurements, so that the business executive can get his facts immediately without going through the process of converting from foreign currencies or measures. It is believed that this is the first time that a book of this nature has been compiled in that manner. Furthermore, it is the first time that all these details of foreign conditions have been available in one volume, as heretofore it has been necessary to consult local publications and various governmental reports in order to cover the same ground.

The countries of the world have been grouped in alphabetical order by continents and other major geographical divisions so that adjoining markets are found together.

Under each country will be found detailed information upon area and population, commerce, production and industry, railroads, telegraphs and telephones, money, weights, measures, commercial language, local advertising media, principal shipping routes, customs tariffs, consular regulations and consular representatives, cable rates, mail time, postal rates, and regulations respecting parcel post, money orders and reply coupons. The section under each country dealing with commerce contains tables showing the value of the total foreign trade for a series of years, the value of imports and exports by commodities and countries, and the value of its imports from and exports to the United States for ten or more years.

Under production and industry there will be found with respect to each country a detailed survey of its various industries, including agriculture, livestock, forest and mineral resources, fisheries and manufactures, and in the majority of cases there has been included a table showing the number of each kind of manufacturing enterprise, together with the number of persons employed, the capitalization, the value of annual output and the consumption of raw material.

Tables are also given showing the world's production and consumption of the principal grains, minerals and other primary commodities, also the world's equipment of shipping, railroads, telegraphs and automobiles.

Comparative tables showing the relative growth of the export and import trade of the United States, Great Britain, France and Germany are also given.

Separate sections of the book are devoted to the new states of Czecho-Slovakia, Jugo-Slavia, Poland, Finland, Latvia, Lithuania, Esthonia, Ukrania, and Austria and Hungary as reconstructed.

Questions and Answers for Marine Engineers

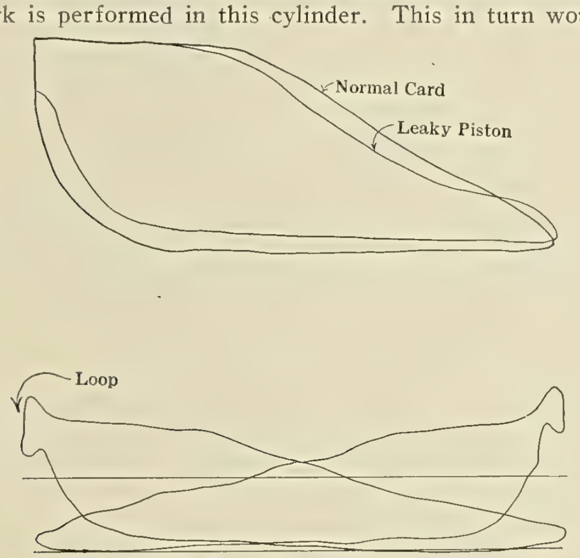
Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Effect of Leaky Piston on Indicator Card

Q. (1048).—Will you please give information in regard to steam indicator cards. How can one tell from the card if there is leakage in the cylinder? For example, if a card from a high pressure cylinder of a triple expansion engine seems to have low indicated horsepower and excessive back pressure, how do you figure just what the back pressure ought to be? J. L. T.

A. (1048).—Should the piston rings or piston leak, a normal diagram would approach that sketched in dotted; that is, the expansion line will drop off, or, in other words, steam blows from the high pressure to the low pressure side of the piston. During the return or up stroke, steam will blow through from the bottom end of the cylinder, with the result that the exhaust line is raised and less work is performed in this cylinder. This in turn would mean a higher admission pressure in the next cylinder of a multiple expansion engine and more work performed there. During compression the compression line should show a level place or even a drop due to steam in compression on the upper side of the piston blowing through to the under side, which is indicated in the curious loop in our diagram.



Indicator Cards Showing Effects of Leaky Pistons

One way of obtaining a rough equalization of power is to alter cut-offs so that the engine runs smoothly with little vibration. If, when indicated horsepower of the cards is worked out, the distribution of power is not good, an estimate of the amount to change the receiver pressure by changing cut-off can be approximated from the previous power and receiver pressures. In one example of a compound engine, which took steam at 85 pounds pressure absolute and exhausted it at 3 pounds absolute, when the low pressure cut-off was adjusted so that the high pressure receiver pressure rose from 11 to 13 pounds, the indicated horsepower was decreased about 4 percent in the high pressure cylinder and increased a corresponding amount in the low pressure. This would indicate that very approximately 1 percent change in "pressure range" (difference between admission and exhaust pressure) would produce a corresponding variation in horsepower.

Raked Smokestacks

Q. (1046).—Will you please tell me why most of the smokestacks on many passenger vessels are set at an angle? T. M.

A. (1046).—This is probably due to the desire to make the smokestack and vessel look snappy. Most sailing vessels have their masts raked, and when steamers were first built it was simply natural to give their masts and stacks a rake. A stack with a marked rake and with wind ahead should slightly increase the draft. However, our new destroyers have stacks which are nearly perpendicular.

Chain for Anchor-Tripping Gear

Q. (1049).—Kindly advise me why it is necessary to use three different size links in an anchor lashing which is secured about as shown in the sketch (Fig. 1). To me it looks as though the pull was equally distributed through the chain and one size link should be used. R. B. R.

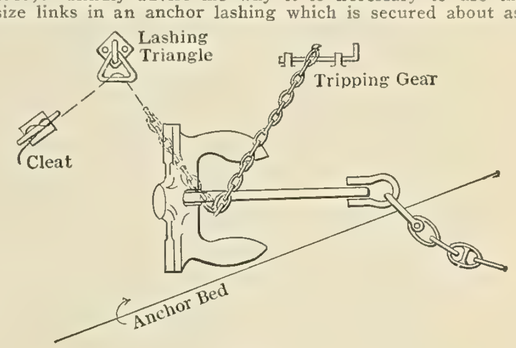


Fig. 1

A. (1049).—I have never seen the tripping gear fitted as your sketch indicates, and likewise cannot understand why three different sizes of links should be fitted in a length of chain which takes stress equally throughout. The only possible partial explanation would be that a shorter link is convenient where the chain is belayed on a cleat.

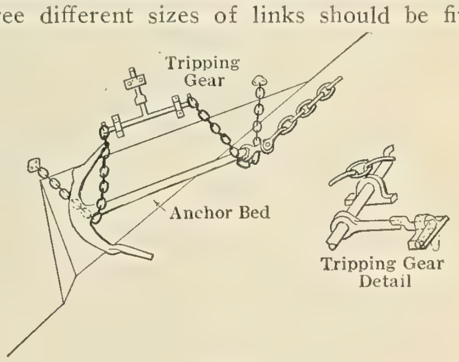


Fig. 2

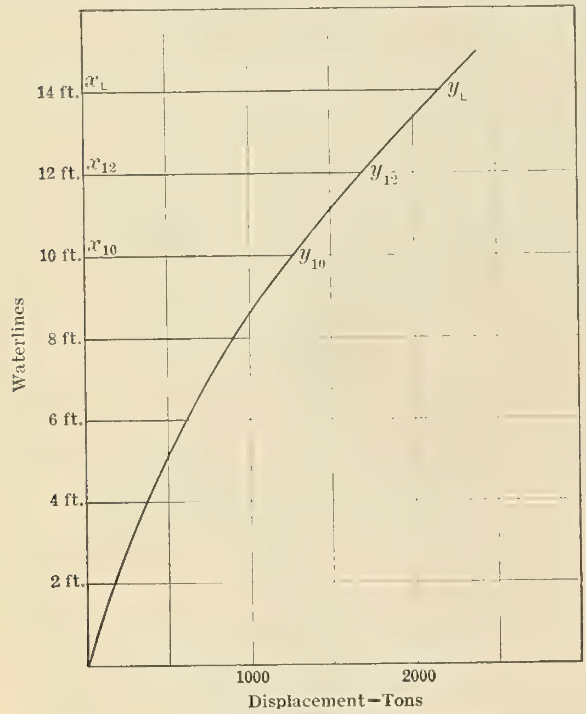
Fig. 2 illustrates a common method of fitting tripping

gear to an admiralty (or navy) type stock anchor. Besides the tripping chains (approximately one-half inch for a 1,800-pound anchor) indicated in the sketch, there are several lengths of about 5/16-inch close link chain used to lash the anchor in place while stowed, but these are entirely separate from the tripping chains.

Relation Between Displacement and Waterline Area

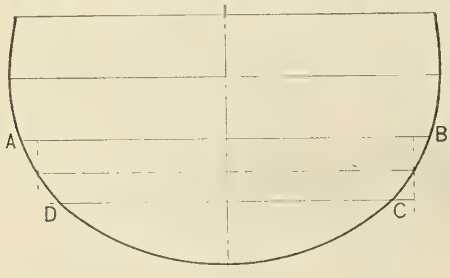
Q. (1045).—What relation has the area of the water-planes to the distance from X to Y on the displacement scale? C. F. T.

A. (1045).—The displacement curve shows the displacement up to the waterline which we are concerned with. The displacement can also be obtained, if we know



Displacement Curve

the areas of the waterlines, by considering the vessel to be made up of a series of solids or slices obtained by cutting the vessel with the waterline planes. The volumes of these solids may be added to find the displacement of the vessel up to any required waterline (a displacement



The volume of the solid whose section is represented by A B C D is taken as the volume of a cylinder of the same height and of sectional area equal to the mean of water lines AB and CD

sheet worked out by the trapezoidal rule would have the displacement computed in this manner). If the distance between successive waterline planes be multiplied by the average of their areas, the volume of the solid or slice will be found quite closely.

Thus, in the case represented by our figure,

$$\frac{A_L + A_{12}}{2}(x_L\, x_{12}) = (y_L\, x_L - y_{12}\, x_{12}),$$

where

A_L = area of the load waterline.
A_{12} = area of 12-foot waterline.
$x_L x_{12}$ = 2 feet.

The above equation is true for all practical purposes, if the waterline planes are fairly close together. Where the curvature of a vessel's transverse stations is considerable, as at the bilge of a cargo ship, the greatest variation will occur. The table given below illustrates the fact that this equation holds, for column (3) represents the second member of our equation and column (6) the first member:

Waterline, Feet	Displacement, in Tons (From Displacement Curve)	Difference in Displacement Between Successive Waterlines	Average Area of Waterline, Square Feet	Average Area of Waterlines, Square Feet	Displacement Between Successive Waterlines, Tons
2	149	.....	2,610	.....	...
4	347	198	4,320	3,465	198
6	626.5	279.5	5,460	4,890	279
8	962	335.5	6,290	5,875	336
10	1,341	379	6,960	6,625	378
12	1,753	412	7,450	7,205	412
14	2,189	436	7,800	7,625	436

Approximate Freeboard

Q. (1053).—Kindly describe a quick and simple method of figuring the freeboard of a vessel. C. H. B.

A. (1053).—The freeboard of a vessel depends upon a good many factors, among which are the following: Type of vessel, strength of hull and houses, sheer of deck, trade of vessel, time of year. You realize, of course, that freeboard markings are placed on vessels by the American Bureau or Lloyds Register (if desired by the owner in this country), and their ruling should be followed, as you can see that a formula based on depth may not take into account the vessel's peculiarity. Furthermore, such associations as The New York Underwriters' will often limit the draft. For full information about the British Board of Trade freeboard see pamphlet "Freeboard Tables" published by them; however, the article by H. A. Everett published in the April, 1917, issue of Marine Engineering will be found very interesting.

The American Bureau *formerly* published a suggested freeboard allowance which in the cases of the ordinary cargo steamer will give a freeboard roughly one foot greater than that assigned by the Board of Trade. An abstract of this table is given below:

Depth of Hold from Top of Ceiling to Underside of Deck (Main Deck), Feet	Freeboard at Lowest Point of Sheer for Each Foot Depth of Hold, Inches
8	1½
12	2¼
16	2½
20	3
24	3¼
28	3½

"Hurricane deck vessels having no water ports fitted at the second deck, also raised quarter deck vessels, may have less, but suggest that hurricane deck vessels have not less than one-half and quarter deck vessels not less than three-quarters of the freeboard in the table. The depth of hold and freeboard to be measured from the second deck in hurricane deck vessels. . . ."

The writer would suggest that the following formula will give approximately the freeboard for an ordinary cargo vessel of over 20 feet depth, having a normal sheer, the freeboard being measured from the weather deck:

$$\text{Freeboard} = .40 \text{ depth} - 6.0 \text{ (feet)}$$

Depth = depth from top of keel plate to weather and strength deck (foot units).

PERSONAL MENTION

A. Shearer, formerly works manager of the Halifax Shipyards, Ltd., Nova Scotia, Canada, has been appointed manager of the Turkish Arsenal, Constantinople, Turkey, controlled by Sir W. Armstrong, Whitworth & Company, Ltd., and Vickers Limited, of Elswick and Barrow, England. When Mr. Shearer became identified with the Halifax Shipyards, Ltd., in 1917 he took over the existing dry dock from the Halifax Graving Dock Company and laid out and began the operation of a four-berth shipyard next to the dry dock on the ruins of the Arcadia Sugar Refinery, which was destroyed by the great Halifax explosion. Here keels for the first two 10,000-ton vessels ever built in Nova Scotia were laid. Having completed that work, Mr. Shearer returned to England and was appointed to his present position.

Edward Granville Tuck, recently appointed as chief surveyor of the American Bureau of Shipping, is a native of the state of Maine. Reared as he was in a shipbuliding community, he began his training at the Bath Iron Works, where he spent five years in learning the details of the business. In that period, begun as an apprentice, he emerged as assistant foreman of hull construction. The Eastern Shipbuilding Company, organized primarily for the construction of the two Northern Pacific mammoths among American ships, the *Minnesota* and *Dakota*, next demanded Mr. Tuck's services, and he was employed throughout their entire construction as foreman in charge of mold loft and fabrication. Having mastered the details of construction in the mold loft and building yards, he became a ship draftsman, and as such has served a number of years in some of the leading American shipyards, including Cramps, Newport News, Fore River and Harlan & Hollingsworth. In several of these yards he has been draftsman in charge. In 1917 he was first employed by the American Bureau of Shipping as a surveyor, and was soon appointed assistant to the chief surveyor for the Pacific coast. In that capacity he became thoroughly acquainted with all the shipyards in the West. Mr. Tuck's appointment to the important position of chief surveyor of the American Bureau came in the nature of a well-earned promotion. His many years of experience in the various branches of shipbuilding, combined with an obliging and courteous disposition, make him peculiarly adaptable for the position which he now fills.

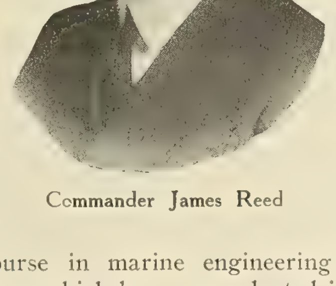
E. G. Tuck

Commander R. D. Gatewood, of the Construction Corps, U. S. N., has been selected by Rear Admiral Benson, chairman of the Shipping Board, as director of construction and repair of the Emergency Fleet Corporation, relieving R. L. Hague, of San Francisco, resigned. Commander Gatewood graduated from the Naval Academy in the class of 1903 and from the post graduate course of naval architecture and marine engineering at the Massachusetts Institute of Technology in 1906. He has been in charge of repairs and new construction on both the Atlantic and Pacafic coasts, and for two and one-half years was fleet constructor of the North Atlantic fleet. During the war he was superintendent of motive power for the Panama Railroad in charge of the large shops and dry docks at both ends of the Isthmus and made an enviable record in connection with the extensive repair and refitting work on merchant vessels.

Arthur W. Kirton, contract inspector of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., sailed for Sweden on the *Olympic* on July 7 to witness the trials of the new Swedish battleships *Drotting Victoria* and *Gustaf V*, which are equipped with Westinghouse geared turbines. Mr. Kirton has traveled all over the world in the interest of the Westinghouse Company and has spent several years in South Africa, Russia and South America. He is well known to a large number of marine men, especially because he has been in charge of the Westinghouse Marine Turbine School at South Philadelphia.

Arthur W. Kirton

Commander James Reed, Construction Corps, U. S. N., has resigned from the naval service to become assistant general manager of the Los Angeles Shipbuilding & Dry Dock Company, San Pedro, Cal. Commander Reed was appointed to the Naval Academy from Ohio in 1898, graduating in 1902, and after spending two and one-half years at sea with the North Atlantic Fleet, serving both on deck and in the engine room, principally on the battleship *Alabama*, he was selected for the Construction Corps and ordered to the Massachusetts Institute of Technology for the post-graduate course in marine engineering and naval construction, from which he was graduated in 1907 with the degree of Master of Science. After graduation, Commander Reed spent two and one-half years at the League Island Navy Yard, Philadelphia, principally as shop superintendent, and from 1910 to 1911 was inspector of hull material for the Navy Department, with headquarters in Philadelphia. Early in 1911 Commander Reed was sent to South America on duty "furthering American trade" under the State Department, and upon his return was granted leave of absence by President Taft to accept the position of As-



Commander James Reed

sistant Director of Public Works of the city of Philadelphia under the reform administration of Mayor Rudolph Blackenburg. In 1914, after an appointment at the Puget Sound Navy Yard as shop superintendent, Commander Reed went to Mexico as fleet constructor on the staff of Admiral Thomas B. Howard, who was then commander-in-chief of the Pacific Fleet. In the fall of 1914 he was ordered to the Mare Island Navy Yard, continuing on duty there principally as new work superintendent in the hull division in connection with the building of tankers, destroyers and battleships until his resignation from the naval service on April 20. Commander Reed is a member of the Army and Navy Club of New York, the University Club of Philadelphia, the American Society of Mechanical Engineers, and upon acceptance of his resignation from the Navy was enrolled in the Fleet Naval Reserve as lieutenant-commander in the Construction Corps.

James P. Roe, engineer and metallurgist, has been appointed general superintendent of the Reading Iron Company, Reading, Pa. Of Welch birth, Mr. Roe began his apprenticeship in the engineering field when he was only twelve years old at the Consett Iron Works, Consett, England, where he went through the pattern shop, machine shop and drafting room and subsequently became assistant mechanical engineer of the Consett Works. Coming to America at the age of twenty-three, he became associated with the Pottstown Iron Company and worked up through the various grades to the position of general superintendent. In 1890 he resigned to become general superintendent of the Glasgow Iron Company's interests, which then comprised the Valley and Glasgow mills. In March, 1898, his sphere was enlarged when the Glasgow Iron Company leased the plants of the Pottstown Iron Company. Mr. Roe is the inventor of the Roe mechanical puddler, the exclusive rights to which for the manufacture of pipe were secured several years ago by the Reading Iron Company. On account of the restrictions on building operations imposed during the war, the plant which the Reading Iron Company built for the purpose of placing the mechanical puddler on a successful production basis was closed for a period of two years. The first of this year the department was again put into operation and it is expected that under Mr. Roe's personal direction the plant will soon be operating successfully on a production basis. Mr. Roe is an active member of the American Iron and Steel Institute, the American Society for Testing Materials, and the British Iron and Steel Institute.

James P. Roe

Brigadier-General Frank T. Hines, U. S. A., has been appointed Chief of the Inland and Coastwise Waterways Service of the War Department, which is an entirely new bureau created by a recent act of Congress. During the world war General Hines had charge of overseas transportation and later was chief of the Bureau of Transportation, which, under the Army reorganization act, was merged with the quartermaster general's office.

F. B. Cole has been appointed assistant district manager in charge of construction of the North Atlantic District of the United States Shipping Board Emergency Fleet Corporation, with headquarters at 45 Broadway, New York.

William B. Ferguson, who has been connected with the American International Shipbuilding Corporation since its inception, has become associated with the Philadelphia Engineering and Sales Corporation as president.

R. H. Cooper has resigned from the Shipping Board after serving for three years as assistant to Harold H. Ebey, director of operations. He will become vice-president and general manager of the Export Transportation Company, of Baltimore.

Thomas D. Pitts, manager of the Delaware River District of the Division of Construction and Repairs of the Shipping Board, has been promoted to be manager of construction, succeeding F. P. Baldwin. J. J. Eason has been appointed to succeed Mr. Pitts in the Delaware River District.

E. M. Herr, president of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., was recently decorated with the Order of the Rising Sun by the Emperor of Japan.

Victor T. Noonan, formerly safety engineer at the Fore River, Mass., plant of the Bethlehem Shipbuilding Corporation, has become a public consulting engineer on accident prevention in industry.

Roy S. Mac Elwee, New York, assistant director of the bureau of foreign and domestic commerce, has been confirmed by the Senate to be director of the bureau to succeed Philip B. Kennedy, whose resignation became effective July 1. Mr. Mac Elwee is the author of *Ports and Terminal Facilities* and a number of pamphlets on foreign trade subjects.

Major General William M. Black, who retired from the army last October, has resigned as an advisory engineer with the Shipping Board because of the ruling by the Treasury Department that the board cannot pay the expenses of retired army and navy officers serving with it. General Black was formerly in charge of the engineers' corps of the War Department.

Max Hansen, naval architect, marine and mechanical engineer, formerly connected with the McBride & Law Shipyard as manager of construction, has opened an office as naval architect and consulting engineer in Beaumont, Tex. Mr. Hansen has been previously connected with some of the foremost shipbuilding concerns in the United States.

Captain Frank E. Ferris has been appointed special commissioner of the United States Shipping Board and the Emergency Fleet Corporation, with headquarters at 8 Grosvenor Gardens, London, in place of Captain E. C. Tobey, resigned.

H. Birchard Taylor, vice-president of the William Cramp and Sons Ship and Engine Building Company, Philadelphia, has been elected president of the Atlantic Coast Shipbuilders' Association. F. P. Palen, vice-president of the Newport News Shipbuilding and Dry Dock Company is vice-president, and W. T. Smith, vice-president of the Merchant Shipbuilding Corporation, treasurer. The administrative council consists of Joseph W. Powell, E. C. Bennett, J. Harry Mull, M. A. Neeland, W. T. Smith, S. M. Henry, F. P. Palen, H. L. Brittain, W. G. Coxe.

Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

AMERICAN SHIPS AND SHIPYARDS ABLE TO MEET COMPETITION

National Foreign Trade Council Optimistic as to the Future of Our Merchant Marine; Government Should Permit Freedom of Action; Some Valuable Suggestions.

In a report of the Merchant Marine Committee of the National Foreign Trade Council, recently presented by Welding Ring, an outlook so encouraging that it may be called optimistic is expressed as to the future of American shipping and shipbuilding. American shipyards, the report states, will be able to compete favorably with foreign yards, and it is held that the revision of the navigation system will enable the operation of American ships on a competitive basis. Sale to foreigners is urged of the less desirable types of vessels owned by the Government, and opposition is voiced to any Government dictation as to trade routes, freight charges or methods of management.

The report, as presented by Mr. Ring, states:

"The National Foreign Trade Council has considered, and from time to time issued statements outlining its views upon the question of the employment and disposition of that portion of our merchant marine built under the auspices of the Shipping Board and acquired as a result of the war. The final declaration of the Sixth National Foreign Trade Convention, unanimously adopted, read as follows:

"'While Government ownership and reasonable Government control of American shipping must continue until some acceptable plan is devised for the transfer of such tonnage to private ownership, we are opposed to any continuance of Government operation, and urge that, consistent with recognized war emergency needs, these Government-owned vessels be allocated to suitable trades and trading routes for operation by any qualified competent American shipping enterprise, under conditions of sale or charter that will permit of their sending the American flag to any port of the world on a fair trading competitive basis with that of any other maritime nation.'

"Among the factors on which this declaration was predicated are the following: The American merchant marine will have increased when the present construction programme of the United States Shipping Board is completed, together with additional vessels laid down by private owners, to approximately eight times the tonnage in the overseas trade on June 30, 1915.

Freedom of Action Urged

"The future of the American merchant marine depends on the opportunities which it will offer to the employment of private capital and private initiative. It is generally conceded among ship owners and shippers that no limitation should be placed upon the absolute freedom of carriers to change their freight rates to suit the competitive conditions of the freight market. The merchants and manufacturers of the United States should be enabled to compete with their rivals in other countries without Governmental intervention or supervision of transportation charges. It is recognized by all that our merchant marine must be used primarily to develop the commerce of the nation as a whole, but as it is generally agreed that this development can be accomplished only under private ownership and management, there should be no dictation as to trade routes, freight charges or methods of management.

"No policy can be successful ultimately which involves the operation of steamers in any service at a loss. Such operation involving a deficit which would necessarily be made up from the national treasury, would amount to the bestowal of a bounty upon most favored commodities or producing communities or substantially a subsidy to such steamship lines, a practice generally condemned as inimical, economically unsound and unnecessary from the standpoint of foreign nations' experience.

Proposal for Sale of Ships

"Little opposition, therefore, has developed to the following fundamentals of a national shipping policy. Legislation should be enacted to enable the proper disposition of as large a proportion as possible of the present fleet owned by the United States Shipping Board, to avoid incurring additional loss to our Government by the further decline of values or freight rates. Such legislation should insure to all purchasers of these ships uniform terms of sale and conditions, and the opportunity of developing plans with relation to the establishment of permanent or temporary trade routes for ships under their own management or ownership.

"An unequivocal policy must be established promptly by legislation providing that sales will be made to all responsible buyers at prices determined by the present cost of construction of vessels of similar tonnage and specifications in the best qualified of American shipyards. It is manifest that this should be the basis of comparison, rather than the cost of production in foreign shipyards, which necessarily varies in respect to the country of manufacture, labor conditions and supply and demand. The terms on which such sales should be made should be such moderate percentage of cash payments as would enable a prompt disposition of these ships without any undue hardship being imposed upon our banking institutions or increasing any stringency of money which may exist at the time of sale.

"The percentage of the periodical subsequent payments should likewise be fixed, with due regard to the present world-wide demand for American exports and the increasing consumption in this country of foreign products which may be expected to insure for a considerable period the existence of profitable freight rates.

"Such period and percentage of payments should give to the buyer a reasonable opportunity to amortize such proportion of his investment over a period of years as would enable the writing down of the original cost of his vessel to a competitive value in later years with any subsequent reduction in the cost of shipping. This period of time should be measurably commensurate with that in which the partial and final payments are to be made.

Chartering Policy Outlined

"It is reasonable to suppose, notwithstanding that such easy terms of payment, although fair alike to the Government and shipping community, may be evolved, that it will be difficult to dispose by outright sale of upwards of 1,500 vessels aggregating some 10,000,000 gross tons within a short period. It is manifest, therefore, that during the process of negotiations for the sale of the complete

fleet, built and building, vessels unsold must be chartered to competent and responsible operators on equitable terms comparable to the sale price. Such charter term can, of course, take suitable cognizance of the current conditions of the freight market in respect to the trade routes in which the vessels are to be operated, and such charters can be made subject to sale.

"It is not believed that theories with respect to the application of profits derived from charter operations to the purchase price of ships or the partnership of the Government with shipping companies on a profit-sharing basis, will prove practical.

"The operations of the Shipping Board, or such department as may be evolved, should be confined to the outright sale and actual charter of the vessels in accordance with such legislation as may be enacted. It is the opinion of many of our most able shipping men that having regard to a considerable surplus of ships already built, and now building, of a character not entirely suited to the requirements of our overseas commerce, no restrictions should be imposed on the sale of such vessels to foreign buyers. It is manifest that the exigencies of the world war required the construction of hundreds of vessels of a size, tonnage and equipment uneconomical to operate as important units in the carrying of our overseas commerce, but well adapted to meet special trade conditions in other parts of the world.

Sales to Foreigners

"There is no advantage to this country in the effort to operate uneconomical ships, when by their prompt sale the pressing necessities of other nations now suffering for lack of ocean transportation facilities can be alleviated. Moreover, the disposal of such vessels would enable their replacement by the building in American shipyards of vessels of tonnage and construction suitable for overseas commerce. Such method would give to shipyards equipped to produce competitive vessels of types required for our foreign trade greater assurance of continued employment.

Suggestions have been made of the imposition of additional duties on goods imported in foreign bottoms, or, what is tantamount, by the reduction of duties on goods imported in American ships. The liability to reprisals from such procedure requires careful consideration. Nor should it be forgotten that the present demoralization of European productivity and exchange, in which problems the future of our export and import trade is inextricably involved, can be sensibly lessened by affording to the European nations the immediate use of transportation facilities which are vital to their national prosperity and even their existence.

"The retention of such surplus tonnage by us may merely impose a glut of unnecessary and unserviceable ships on our market, depreciating the value of the suitable vessels and hindering the working out of a programme of prompt disposition at favorable prices.

"It is well known that the shipyards of the principal maritime nations are filled to capacity for a long time to come, and we must consider not only that this establishes a favorable market for the disposition of ships unsuitable or unnecessary for our needs, but we must picture the effect of the selfish retention of such ships on our part as against the exigent demand for them, especially by European nations, some of whom were our associates in the war.

Shipbuilding Situation Favorable

"The Foreign Trade Council has already placed on record its conviction that American shipyards will be able to produce tonnage at rates and under conditions that will compare favorably with those obtaining in foreign maritime countries. There will be no return, for some time at least in any country, of so-called pre-war prices of materials and labor. Shipbuilding materials and equipment are on a lower level in the United States, since the signing of the armistice, than in any other producing country.

"There is a present disparity in favor of the American shipbuilder of approximately $40 per ton in the price of steel shipbuilding material, and while wages in most foreign shipyards are appreciably lower than in ours, the factor of efficiency compensates to a large extent. It is therefore believed that at least for the extended period in which there should continue a good demand for vessels of the size and construction appropriate to the needs of overseas commerce, American shipbuilders can compete with the world. As the restrictions on the building of ships for foreign account have been removed during the past year, it is difficult to understand the contention that all the Shipping Board vessels, irrespective of size and suitability, should be reserved exclusively for operation under the American flag.

"The investigation of the American navigation system which the Shipping Board was directed by its organic act to effect is now under way. It should be completed with the least possible delay, and the revision and improvement of the navigation system contemplated by the Shipping Act should enable the operation of the American merchant marine on a competitive basis."

U. S. to Build for Mexico

Gen. Salvador Alvarado, Minister of Finance in the cabinet of the provisional President of Mexico, Adolfo de la Huerta, arrived in San Antonio, Tex., recently from Mexico City, and said he was on a threefold mission to the United States. He expects while in New York to ratify contracts for the construction of approximately fifty ships ordered from American builders.

Contracts for rolling stock for Mexican railroads are also on the list.

MARINE ENGINES IN CHINA

Good Demand Reported for High Speed Low Weight Equipment

United States consular reports from Canton and Hongkong, China, with reference to marine engines, show that a large number of the tugs used in the district are idle because of the prohbitive price of coal, and that orders for crude oil engines have been placed with a native company. To convert these steam tugs a crude-oil engine developing 120 horsepower would be needed. It is suggested that manufacturers of heavy-duty engines who are interested correspond with the Canton consulate.

Most of the motor launches owned in Canton are equipped with American motors, sold by non-American firms who could not get European motors. One Canton firm has sold twenty American motors in the past ten months, and plans an extensive marine motor import department, and American engines will be handled if satisfactory arrangements can be made. A British firm in Hongkong has sold about forty engines in this district. This firm has no office in Canton. The most popular American motor which this firm sold during the war (a four-cylinder marine motor, developing 24 brake-horsepower at 450 revolutions per minute) is sold at $2,400, Hongkong currency. Hongkong currency $100 has not been worth less than $75, United States currency, during the past twelve months. Orders for this engine sent direct to the factory would result in placing this engine on the market in Canton at a cheaper price.

Another British firm, which holds the sole agency for two famous American marine motors, manufactures marine motors at its factory in Shanghai. With the exception of one firm, which is located in Canton, the non-American firms, which have acquired sole agency privileges for American marine motors, have not actively pushed the sale of marine engines. Their position has been one of receiving orders, not of seeking them.

Some two years ago the demand for light marine engines was confined to 4 to 8-horsepower, one or two-cylinder, two-cycle engines. But now every buyer who contemplates having a launch built wants an engine that will produce a speed of at least 15 miles an hour. Thus the type of engine wanted is a high-speed, low-weight kerosene engine, with high-tension magneto ignition, arranged so that the cylinder heads are removable. Engines of this type, developing from 10 to 35 horsepower, can be sold in increasingly large numbers. High-powered engines are purchased by business houses for the use of members of their staffs; the real market for speed-model marine engines exists among the official and wealthy-class Chinese. They are fast learning the charms of a speed boat. Five hydroplane boats built by a young American-Chinese, which develop about 30 miles an hour,

have made speed boats the desideratum of hundreds.

The river, with its two reaches and deep, broad channel, has long been the playground of the wealthy. Flower boats, so called, which are floating restaurants, are being modernized. Electric lighting units, low-speed marine motors and plumbing are being installed.

In the Hongkong district there are no means of ascertaining the value of the present trade in internal combustion engines. The imports of these engines and plants into Hongkong in 1918, reported by the statistical department of the Hongkong Government, were valued at $1,053,425, of which a value of $66,626 were re-exported. Almost all of these imports came from Great Britain.

On the other hand, the imports of such engines in the first three months of 1919 were valued at $39,259, of which machines to the value of $27,696 came from the United States, representing commercial demand. Most of these imports were internal combustion marine engines, for which there has been a steady, strong demand during the past five years.

The only promising means of introducing these engines in this field is through the important commision houses. Connections will probably not be easily obtained, but a strong firm with plenty of energy and a reasonable amount of advertising help from home ought to do a good business from the start. At present American engines of this type are in high favor.

TODD MEN GET STOCK

$1,000,000 Distribution Among Faithful Employees

William H. Todd, president of the Todd Ship Yards Corporation, on July 1 fulfilled a promise he made four years ago by distributing among 727 employees at the various plants of the corporation paid-up stock to the value of approximately $1,000,000.

On July 1, 1916, he offered stock to the workmen who stuck by him during the four following years in proportion to their responsibility, and on July 1 this year he made good his promise. The stock had been deposited in the names of the men who subscribed to the agreement, and they acquired 25 percent of its par value each year until the end without cost to themselves, collecting dividends in the meantime.

The distribution was made at the Robins and Tebo plants in Brooklyn and the Tietjen & Lang yards in Hoboken. Mr. Todd was the recipient of many valuable tokens of the esteem in which he is held by his employees, and expressed regret that more had not come in when the idea was first broached, but intimated that there would be another chance if the company could see its way clear to put it into effect.

One feature of the arrangement is that one-half of the stock delivered may be deposited with the company, and at the end of the next four years will be returned to the men who stay on, doubled, they drawing any dividends that may be declared. The Todd stock is now quoted around $165 a share and the bonuses ranged from $165 to over $8,000.

The corporation stock for the year ended March 31, 1920, after depreciation, Federal taxes and sinking fund were provided for, showed earnings of $66.89 a share, as compared with $11.93 per share earned in the previous year.

As explained by an official of the company, the plan was not conceived as a bribe to the employees to forsake their unions, but by making them partners in the business to arouse their ambition and thus make Todd work continue on its present high plane.

The gifts to Mr. Todd included a diamond studded watch from the office force of the Robins plant, and a gold fob with Masonic emblems from the other offices, a handsome golf outfit from the Tebo Yacht Basin, a beautiful silk American flag from the Clinton plant, a silver mounted, fully equipped, traveling bag from the White Fuel Oil people, a large gold tablet, suitably inscribed, from the Tietjen & Lang forces, and a big, three-handed silver loving cup from the Seattle and Tacoma yards.

Mr. Todd later started for Seattle to complete the distribution of stock among the employees in the Pacific yards who have stuck to their jobs and taken advantage of the offer made four years ago.

AMERICAN ENGINEERS PLAN CARGO SHIP WITHOUT RIVETS

Big Saving of Materials, Labor Costs and Cargo Space Claimed for Welding System, with Increased Strength

Following the recent launching of a 500-ton rivetless steamer in England, J. S. Dudley, research engineer, and L. L. Holladay, electrical engineer of the Merchant Shipbuilding Corporation, owners of yards at Harriman and Chester, on the Delaware, announce that they have completed designs for an 8,800-ton Emergency Fleet type freighter, to be built without rivets. The hull will be 401 feet long and 54 feet molded breadth, with a displacement of 12,231 tons. Mr. Holladay describes the ship as follows:

"The hull is electric welded throughout and therefore wholly without rivets in its construction. In addition to certain beams, keel, keelsons, etc., running longitudinally, the bottom shell plating, sheer strakes and deck plating run longitudinally; however, the side shell plating, top plates to double bottom and bulkhead plates run transversely or vertically. All plates are abutted without lapping straps or angles and then are welded with a joint 95 to 100 percent as strong as the abutting steel members; which results in the elimination of all overlapping steel in plating, liners, angle irons for joining structural parts, stapling and rivets.

"As this material was added originally only incidentally or unavoidably, and for no purposes of strength or stiffness, therefore, none or only minor compensation need be made for its removal. We may, therefore, expect a saving of steel due to elimination about as follows:

Overlapping of plates at points	5½% or 160 tons
Angle-irons uniting structural parts, stapling, etc.	7 % or 203 tons
Liners	1 % or 29 tons
Rivet heads	2 % or 58 tons
Total	15½% or 450 tons

"The thickness of shell plates remains the same as in the standard riveted ship, notwithstanding the efficiency of the welded joint is 95 percent, whereas the efficiency of the riveted joint averages only about 75 percent. This course is conservative, and possibly preferable, until experience has demonstrated that thinner plates may be used with safety. The largest commercial sizes of plates are used to reduce the amount of welding to a minimum and keep strength up to a maximum.

"In order to enable welders to work with the greatest ease, speed, efficiency and reliability, a maximum of welding is to be done on a flat, horizontal surface, a minimum on a vertical surface, and overhead welding is practically excluded. Owing to the elimination of about 450 tons of useless metal in the hull, the initial cost of material will be reduced accordingly. By the substitution of electric welding for riveting a great deal of labor will be saved, as follows: Mold loft work, laying out of shapes and plates, transportation and handling of steel considerably reduced, and punching, reaming, drilling, riveting and calking eliminated.

"By increasing the thickness of plates by about 15 percent to make up for the steel eliminated, and considering a welded joint has an efficiency of 95 percent against 75 percent for a riveted joint, the electric welded ship will be 45 percent stronger than the riveted ship for exactly the same weight, or this excess may be set up against any fancied weakness in the welded ship.

"To sum up, the electric welded ship will contain about 15 percent less steel, will take 40 percent less labor, will take 25 percent less time for construction, will take 2 percent less power for propulsion, will be cheaper to maintain, and be of 5 percent greater capacity.

"The outstanding and unquestionable net gain of such a welded ship over its counterpart assembled by riveting is the increase in cargo-carrying capacity of more than 500 tons, which, when translated into earnings, represents little less than a revolution in shipbuilding and ship transportation."

AMERICA BUILDING FEWER SHIPS

World's Total Construction Falls Off Four Percent

Although nearly a million and three-quarters gross tons less of shipping are being built in the United States to-day than a year ago, the reduction in the world total under construction is less than 4 percent, says a statement just issued by *Lloyd's Register of Shipping.* Returns from all countries for the quarter ended July 1 show an aggregate of 7,720,000 tons under way, compared with 8,017,000 at this time last year.

The sharp decline in American building has been almost completely offset by gains made by practically all the other maritime countries. On July 1, 1920, there was under construction in the United Kingdom more than a million gross tons in excess of the July 1, 1919, figure, while all other countries combined, exclusive of the United States, showed an increase of over 400,000 tons. The American aggregate of 3,874,000 tons a year ago has now declined to 2,105,000 tons.

To-day, therefore, according to the returns, the United States is building 1,472,000 tons less than the United Kingdom, whereas, a year ago America led by 1,350,000 tons.

A notable feature of the returns from all countries is the indication that the United States is taking effective steps to remedy its shortage of larger-sized vessels. The 366 steel steamers building in American yards represent an aveiage per ship of 5,609 gross tons, as against 4,012 tons for the 888 British vessels and 2,985 tons for the 655 building for the rest of the world.

Lubrication of Hack Saws

To prolong the life of hack saw blades and to increase their cutting speed it is necessary to use some form of lubricating compound. The purpose of a lubricating liquid is not so much to lubricate the work as it is to keep the blade cold. The blade is comparatively thin and loses its temper easily, especially since high cutting speeds on machine-driven saws are maintained. For this reason there should be a constant flow of water or compound over the work except in the case of iron castings.

In order to determine the best lubricant for the efficient operation of hack saws, the L. S. Starrett Company, Athol, Mass., recently conducted a series of tests which resulted in developing a compound consisting of one quart of sal-soda thoroughly dissolved in ten gallons of cold water, to which was added a mixture of four quarts of mineral and lard oil.

A New Diesel Engine

The Worthington Pump & Machinery Corporation, 115 Broadway, New York, announces the development of a 2,400-indicated horsepower marine Diesel engine. This engine, built at the Snow-Holly Works, Buffalo, N. Y., of the Worthington Company, is of six-cylinder, 4-cycle type, having a cylinder bore of 29 inches, stroke of 46 inches, and operating at 120 revolutions per minute. This engine has proven so successful in its preliminary tests that the Worthington Company is prepared to produce this engine on a commercial basis, as well as to carry through the design of such other sizes of marine Diesel engines as it may require for installation in American motor ships.

Drop-Forge Combination

The drop-forge and wrench factories of the Whitman & Barnes Manufacturing Company, of Chicago and St. Catherine's, Ont., have been merged with J. H. Williams & Company, of Brooklyn. This consolidation leaves the Whitman & Barnes Manufacturing Company as exclusive twist drill and reamer manufacturers. The general office of the company is at Akron, Ohio. J. Harvey Williams will be president of the new company. A. D. Armitage, president of Whitman & Barnes, will be vice-president of J. H. Williams & Co., and W. E. Rowell, Whitman & Barnes' secretary, becomes Western manager of J. H. Williams & Company at the Chicago factory.

The Whitman & Barnes Company will remain in the twist drill and reamer business, retaining its Akron, Ohio, factory, and the entire time and energies of its organization in the future will be directed exclusively to their manufacture. A new and enlarged plant will be constructed, plans for which are rapidly developing.

2,241 Vessels Built in Last Fiscal Year

During the fiscal year ended June 30, the total shipping built in the United States (including a small tonnage built for foreign owners) and officially numbered by the Bureau of Navigation, Department of Commerce, aggregated 2,241 vessels of 3,860,484 gross tons, compared with 2,158 vessels of 3,734,741 gross tons during the preceding fiscal year.

The peak of production, under the vast shipbuilding appropriations by Congress to win the war was reached in the autumn of 1919, and the following winter, when, from September, 1919, to February, 1920, the output was at the rate of 4,250,000 gross tons a year. This great rate was maintained through the proceeds of Federal taxation and of the sales of Liberty bonds applied by Congress to shipbuilding, involving a total expenditure for ships since June 30, 1917, of about $3,000,000,000, with an annual interest charge of about $150,000,000.

New Fletcher Dry Dock

A big addition to New York's ship repairing facilities has been made by the delivery to the W. & A. Fletcher Company plant, in Hoboken, of a steel dry dock, built by John Monks & Sons and the American Bridge & Foundry Company.

AMERICAN BUREAU LEADS

Classifies 60 Percent of United States Ships

Of the tonnage now building or contracted for in the United States nearly 60 percent has been placed exclusively under the supervision of the American Bureau of Shipping, according to a detailed tabulation prepared by J. B. Crowley, statistician of the bureau. Through the ruling of the Shipping Board limiting the classification of its tonnage to the American Bureau, which ruling was made permanent through the enactment of the Merchant Marine Act of 1920, the lead hitherto held by Lloyd's Register of Shipping in this country has been eliminated. The American Bureau is now classing about a million gross tons more of American vessels than the older organization, the totals being 1,804,000 for the American Bureau, 833,000 for Lloyd's, and 362,000 dual.

In his statement, which reviews the shipbuilding position as of July 1, Mr. Crowley puts the known total of vessels under construction or contracted for both Government and private account at 3,119,000 gross tons. This is considerably in excess of the aggregates of construction work recently announced by the Atlantic Coast Shipbuilders' Association and the United States Bureau of Navigation. Mr. Crowley's total, however, includes Shipping Board tonnage for which the keels have not been laid, and also takes in the smaller classification societies whose reports do not figure in the totals of the Atlantic Coast Association. The seeming discrepancy is thus explained. According to the American Bureau's statement, building for private account is 390,000 tons in excess of that for the Government.

In the classification of steel tonnage building for private account, Mr. Crowley's figures show, Lloyd's Register still leads, with 816,000 gross tons, in comparison with 415,000 for the American Bureau. There are also a number of instances in which the same ships are being classed by both societies. This dual classification aggregates 362,000 gross tons, so that the two leading organizations are supervising altogether the construction of 1,593,000 tons out of the total of 436 vessels of 1,690,000 tons given as under way for private account.

Presented in gross tonnage, the Government programme shows a total yet to be completed of 226 vessels of 1,364,000 gross tons, of which 1,272,000 tons is composed of 210 steel contract vessels, 10 requisitioned steel ships account for 62,000 tons, and there are six concrete vessels of 30,000 tons. The figures include 26 steel contract ships, of 263,000 tons, for which the keels are to be laid.

The grand total of 712 vessels, aggregating 3,119,000 gross tons, for both accounts, indicates that the work in sight, at the rate of last year's construction, may keep the shipyards employed for about ten months.

PERSONAL AND BUSINESS NOTES

Mr. E. D. Mitchell has been appointed manager of the New York office of Alfred Herbert, Ltd., 54 Dey street, in place of Mr. W. J. Fuller, recently resigned. Mr. Mitchell is also a director of the Société Anonyme Alfred Herbert, of Paris.

Russell A. Griffin, general sales manager of the National Pole Company, died July 14 of pneumonia. Mr. Griffin was for many years connected with the American Telephone & Telegraph Company, and later with the Western Electric Company before going into the pole business.

"Ad astra per ardua," the motto of the British Flying Corps, has become literally true in the case of Leroy S. Starrett, president of The L. S. Starrett Company, of Athol, Mass., who recently celebrated his 84th birthday by a "trip to the clouds" in a hydroplane at St. Petersburg, Florida.

The consolidation is announced of Westinghouse, Church, Kerr & Company, Inc., and Dwight P. Robinson & Company, Inc., under the name of Dwight P. Robinson & Company, Inc., engineers and constructors, with offices at 125 East Forty-sixth street, and 61 Broadway, New York.

The Worthington Pump & Machinery Corporation, 115 Broadway, New York, announces the purchase from the Platt Iron Works, of Dayton, Ohio, of their drawings, patterns, jigs, templates, special tools, good will and name on oil mill machinery, hydraulic turbines and waterwheels, feed-water heaters, and high-pressure air compressors.

The Emergency Fleet Corporation announces that a portion of the main floor of 45 Broadway, New York, was leased by the Corporation to the United States Mail Steamship Company for one year, beginning July 19, 1920. The lessees recently entered into a charter contract with the United States Shipping Board covering a five-year period.

Seattle has gained another advantage as a shipping center by being made headquarters of a new shipping district to be known as the Puget Sound and Columbia River district. This action by the Shipping Board is the result of a strenuous fight on the part of commercial bodies of the Pacific Northwest to have the district removed from the jurisdiction of the San Francisco office.

The new building of the Chicago Fuse Company, on the former Otis Elevator Company property at Laflin and Fifteenth streets, Chicago, has a total floor space of 125,000 square feet. It is a modern, daylight, two-story factory structure, with a four-story office section, protected throughout with sprinkler system. William W. Merrill, vice-president and treasurer of the company, states that the building has been entirely remodeled in accordance with the most approved ideas of industrial engineering practice and the most modern equipment installed. With the additions contemplated, the buildings and equipment will represent an investment of more than a half million dollars.

The Oxweld Acetylene Company, of Newark, N. J., Chicago and San Francisco, is justly proud of the distinguished service award tendered the company by the War Department of the United States. The award reads: "The War Department of the United States recognizes in this award for distinguished service the loyalty, energy and efficiency in the performance of the war work by which the Oxweld Acetylene Company aided materially in obtaining victory for the arms of the United States in the war with the Imperial German Government and the Royal Austro-Hungarian Government." The award is signed by the Secretary of War and the Assistant Secretary of War, Director of Munitions.

The steamship *Provincetown* was launched on June 19 at the Groton Iron Works, Groton, Conn., with her hull 100 percent complete and outfitting in excess of 90 percent. The *Provincetown* is a single-screw cargo steamer of the shelter deck type, with a poop and forecastle, and with machinery amidships. For handling cargo she has two steel masts with four five-ton booms on each, and two derrick posts, each with three-ton booms, all on the shelter deck. On the after side of the foremast there is one thirty-ton cargo boom. Accommodations for the officers are in a steel deck house amidships, and the crew is berthed in the forecastle and poop in cubicles. She will carry a crew of sixty men. She is built to develop a speed of 10½ knots, and is propelled by a compound turbine of 2,800 shaft-horsepower, the propeller speed being 90 revolutions per minute.

The yard of the Morse Dry Dock & Repair Company, Brooklyn, received thousands of visitors during the first week in July, when the American cup defender *Resolute* and the challenger, Sir Thomas Lipton's *Shamrock IV*, occupied the big 30,000-ton dock of the company at the same time. Official measurements of the cup contenders were taken while they were on the dock, and incidentally repairs were made to the *Shamrock IV*. The Employees' Association of the company tendered a reception to Sir Thomas Lipton, members of the New York Yacht Club and the commanders and crew of the *Resolute* and *Shamrock* on Wednesday evening, July 7, in the yards of the company. An out-door stage was erected, and powerful arcs were installed. The programme included vaudeville, boxing and movies, including views of the activities of the Morse Company. Sir Thomas Lipton manifested great interest in the big dry dock, and was frank to say that there was "nothing like it in England."

TRADE PUBLICATIONS

Tumbling Mills.—Tumbling mills of all types, producted by the Whiting Foundry Equipment Company, Harvey, Ill., are described in detail in this pamphlet. Numerous illustrations show the machines in operation in various foundries throughout the country. The catalogue will be mailed on request.

Marine Auxiliary Machinery.—Catalogue "P" issued by the McNab Company, Bridgeport, Conn., describes the construction and operation of the principal machinery auxiliaries installed in modern vessels. Among other devices produced by the McNab Company which are given in detail are hand and steam-steering apparatus, Brown's hydraulic-steering telemotor, steam cargo winches, steam anchor windlasses, ash hoists, Stone's hydro extractor, steering wheels, pedestals and the like.

"CO" Marine Oil Engines.—To inform the marine field of what has been accomplished in the past few years by the Fairbanks-Morse Company, Chicago, Ill., a catalogue designated 125-C has been issued by this company. The construction and records of operation of marine oil installations are given for units, from 30 horsepower to 300 horsepower. The catalogue contains a description of various types of ships throughout the world which use Fairbanks-Morse engines.

The Sign the World Knows.—This pamphlet, issued by the Vacuum Oil Company, 61 Broadway, New York, is intended for the information of marine engine operators and owners in all parts of the world who find it necessary to study the problem of lubrication. In addition to a general description of the various oils that are needed to insure the proper lubrication of marine machinery, the pamphlet contains a list of seaports throughout the world in which representatives of the Vacuum Oil Company are located, and where oil supplies may be obtained.

Air Compressors.—The first edition of the Pennsylvania Pump & Compressor Company's (Easton, Pa.) Bulletin No. 100 has just been issued describing "Pennsylvania" Class 3-A power drive, single stage, straight-line air compressors. In the pamphlet the general specifications are listed, special attention having been given to the description of a new type ring plate valve and oil float gage used to determine the level of oil in the crankcase. Other features of these compressors, as noted in the Bulletin, are a solid forged crank shaft, a forged connecting rod with solid box eyes and removable bronze shell main bearing.

Reclaiming Crank-Case Oils.—Catalogue No. 102 of the De Laval Separator Company, 165 Broadway, New York, describes the application of the centrifugal principle in reclaiming crank-case oils from all types of internal combustion engines. In the larger installations great quantities of lubricating oils are used, so the matter of oil purification and reclamation is of great importance. The De Laval centrifugal oil purifier has proved to be an efficient means of recovering otherwise waste oil and a description of various types and capacities of this machine is given in detail together with an outline of its operation.

Marine Equipment.—Geared turbines, auxiliaries and refrigerating machines are described in a bulletin issued by the Poole Engineering & Machine Company, Baltimore, Md. This company has made a specialty of small horsepower units of aluminum construction for installation in small boats and this as well as larger installations is described in detail, special attention being given to features of the design of both the turbine and gearing. Some space is devoted in the catalogue to the description of the vertical deck pump drive consisting of a single stage steam turbine and reduction gear. A similar drive may also be applied to bilge pumps. A description of another device of this company, the Ideal Refrigerating Unit, is also given in the catalogue.

Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIPS AND SHIPYARDS

Fabricating Shop, Newburgh, N. Y.—The Newburgh Shipyards, Inc., plans to build and equip a fabricating shop.

Shipyard Sold, Jacksonville, Fla.—The St. Johns River Shipyards have been bought by the Gibbs Gas Engine Company.

Dry Dock, Pascagoula, Miss.—The Gulf Ship Company is to build a drydock at its Pascagoula plant on the Pascagoula River.

Tankers, Argentine, S. A.—The Argentine Government is in the market to buy two oil tankers in the United States and to build two others.

Tanker, Newburgh, N. Y.—The Tank Shipbuilding Corporation, is building a tank steamer of 1,000 gross tons for the Sunset Fuel Oil Company.

Cargo Vessels, Pensacola, Fla.—The Pensacola Shipbuilding Company has secured a contract with an English concern for five 9,000-ton cargo vessels.

Tanker, Chester, Pa.—The Sun Shipbuilding Company is building a bulk oil steamer of 6,000 gross tons for Benham & Boyesen, 8 Bridge Street, New York.

Machine Installation, Perth Amboy, N. J.—Electrically operating pumping machinery, valves, etc., are to be installed by the Perth Amboy Dry Dock Company.

Capital Stock Increased.—The Coastwise Shipbuilding Company, Andrew Street, Baltimore, Md., has increased its capital stock from $2,000,000 to $300,000.

To Sell Shipyard, Jacksonville, Fla.—Negotiations are in progress for the purchase of the Merrill-Stevens Shipbuilding Company's plant from the U. S. Shipping Board.

Shipyard for Sale, Baltimore, Md.—The Shipping Board is arranging for the sale of the Maryland Shipbuilding Company's plant at Soller's Point, comprising 51 acres.

Shipyard Extension, Elizabeth, N. J.—The Bethlehem Shipbuilding Corporation is taking bids for a three-story building at its yards on Front Street, known as the Moore plant.

Increase of Capital.—The William Cramp & Sons Ship & Engine Building Company, Richmond & Norris Streets, Philadelphia, has increased its capital from $6,250,000, to $20,000,000.

Barges, Kearney, N. J.—The Moore plant of the Bethlehem Shipbuilding Corporation, Ltd., has received an order for two 2,500-ton barges from the Western Maryland Railroad Company.

Ship Repair Plant, Newport News, Va.—The Atlantic Ship Service Corporation has been chartered with a capital of $25,000. Frank Richardson, president, and H. R. Lackey, secretary.

Revising Steamer Plans, New York.—Theodore E. Ferris, naval architect, 30 Church St., is reported to be revising plans and specifications for two 400-foot, 15-knot steamers for the "Red D" Line.

Barges, Jacksonville, Fla.—The Gibbs Gas Engine Company is building six barges for M. Garcia, two of which have just been completed. They will be towed to Cuba and used in the sugar industry.

Warships, Japan.—Nine warships have been ordered from the Kawasaki Dockyard and the Ishikawajima Shipyard. The former is to build one cruiser and two destroyers, and the latter six destroyers.

Lighters, Jacksonville, Fla.—The Jacksonville Shipping Corporation is having six lighters built for use in Cuban Harbors in unloading freight. They will be 30 x 80 feet, and carry 100,000 feet of lumber.

To Enlarge Plant, Mobile, Ala.—The Chickasaw Shipbuilding & Car Company plans to spend large sums within the next few months in improvements and additions. A factory to make ships' furniture is planned.

Ford May Buy Shipyard, Detroit, Mich.—It is reported that Henry Ford may take over the Detroit yard of the Great Lakes Engineering Works. Other yards of the company are at Ecorse, Mich., and Ashtabula, Ohio.

Ore Boats, Cleveland, Ohio.—The American Iron & Steel Corporation, Engineers' Building, will build three 12,000-ton boats for carrying ore to its plant. It is a subsidiary of the Lake Superior Iron Ore Company.

Barge, Orange, Texas.—The National Shipbuilding Company will soon start work on a 125-ton barge on the deck of a 300-foot x 40 foot barge, being constructed for the National Oil Transport Company for use in the oil trade.

To Sell Shipyard, Savannah, Ga.—The Foundation Company, Woolworth Building, New York, offers for sale, as a whole or in parcels to suit purchasers, all the plant, ship equipment and other material at their No. 5 shipyard.

Converted Oil Burner, Seattle, Wash.—The new Japanese-built steamer Eastern Importer has been delivered to the Shipping Board. She will be converted into an oil burner at one of the Seattle yards at an expenditure of about $80,000.

Tankers, Seattle, Wash.—The keel for the first 12,000-ton tanker to be built by the Northwest Bridge & Iron Company, for the Swiftsure Oil Transport Company was laid recently. The company has seven of these vessels, which will be of the single-screw type, to build.

Launches First Ship, Victoria, B. C.—The Harbor Marine Company, Ltd., launched its first ship, the Canadian Winner, recently, and a keel for another was laid as soon as the first was off the ways. The latter is a car ferry for the Canadian Pacific Railway Company.

New Shipbuilding Company, Finland.—A new Finnish shipbuilding company has been formed in Abo with a capital of 4,000,000 Finnish marks. The company proposes to build sailing ships with auxiliary motors, and steel vessels of from 1,500 to 2,000 tons deadweight.

Tankers, San Francisco, Cal.—Contracts for building six big tankers for a British oil company, and two for the Standard Oil Company of New Jersey, have been let to the Western Pipe & Steel Company, and they will probably be built at the Schaw-Batcher shipyards, San Francisco.

Fabricated Ships, Italy.—The Italian Government has placed an order with a foreign shipbuilding firm for what is called knockdown steamers. The fabricated material will be shipped to Italy and put together at Palermo. Purchases already made amount to 775,000 tons of material.

Liners, Glasgow, Scotland.—Harland & Wolff are beginning the construction of two liners for the Australian service, one for the P. & O. Line of 13,000 tons of the P. & O. "B" type, of which Harland & Woll are reported to have five on order, and a 12,000-ton vessel for the Aberdeen Line.

Wants Tanker Plans, San Francisco, Cal.—W. W. Johnson of the Union Construction Company is in the east to secure plans and specifications for the construction of a number of tankers for Coast oil companies. How many are wanted is not given out, but they will go into the Pacific oil carrying trade.

To Repair Turbines, Brooklyn, N. Y.—With the addition of a balancing gear to the equipment of its large machine shop, the Morse Dry Dock & Repair Company is now enabled to undertake complete turbine repairs, and is the only ship repair yard in the port of New York possessing such equipment.

Tankers and Tugs, Port Richmond, N. Y.—The Staten Island Shipbuilding Company, is building six 2,000-horsepower ocean tugs for the United States Navy; one tank ship for the Tidewater Oil Company and one tank ship for the Galena Oil Company, and will have the ways ready shortly for two 10,000-ton ships.

Floating Drydock, Chester, Pa.—The Sun Shipbuilding Company has begun work on the basin for its proposed 10,000-ton floating drydock, and hopes to have the dock in operation by March, 1921. The basin is being built large enough so that another dock of any necessary size may be added if business warrants.

Shipbuilding, Germany.—The German Reichstag has appropriated 98,000,000 marks to be used for the rehabilitation of merchant marine. Under provisions of the treaty of peace, the German Government must arrange for the construction of 200,000 tons of new ships annually for five years to be turned over to the allies.

Cargo Vessels, England.—Seven new ships are under construction for the Royal Mail Steam Packet Company, London some of which will be put into the company's South American service. Two others are being specially constructed for the frozen meat trade and will be fitted with the most complete freezing installation yet invented.

Steamer Wanted, New York.—The Isle of Pines Steamship Company, 225 Fifth Avenue, is in the market for a freight and passenger steamer, from 135 to 150 feet long, 28 to 36 feet beam, and loaded draft not to exceed 7½ feet. The vessel will be used for the run between Batabano, Cuba, Nuevo Gerona and other ports on the Isle of Pines.

Shipyard Sold, Tacoma, Wash.—The buildings and supply of timbers, and a large amount of tools of the Wright Shipyards have been sold to the Garrish Supply Company, and Donald McGregor, of Tacoma, machinery supply dealers. The ways and buildings of the yards will be razed or sold unless some of the building should be used for machinery storage.

Rebuilding Barge, Sturgeon Bay, Wis.—The Leatham & Smith Towing & Wrecking Company is rebuilding the Pere Marquette, which was converted a couple of years ago into a barge, renaming her the Wisconsin. The vessel will have a boiler and engine installed, and be made into a package freighter for the Chicago, Milwaukee & Michigan City Line, Milwaukee, Wis.

For Floating Steamer, Alpena, Mich.—Tenders are solicited for floating, righting and delivering the steamer D. R. Hanna sunk by collision in about 23 fathoms of water off Alpena in Lake Huron. Tenders for the purchase of the vessel as she lies are also solicited. For terms and particulars address R. Parry-Jones, Lloyd's Agent, Kirby Building, Cleveland, Ohio.

Schooner, San Francisco.—Frank Stone has received a contract from Fanning Island, Ltd., a British concern having trading stations on Fanning and Washington Islands, for the construction of a three-masted schooner to carry ten first-class passengers as well as cargo. She will have a 130-horsepower auxiliary engine, with electricity for cabin fans, etc., and other first-class equipment.

Contracts for Tenders, City Island, N. Y.—Kyle & Purdy ha e contracted with the International Petroleum Company for a 132-foot steel maintenance tender; it will have 450 horsepower fore and aft compound inverted engines, 18 x 38 x 26 inches stroke, with one three-furnace Scotch boiler; also for a duplicate of this vessel with the Atlantic Gulf Oil Company. These are to be used as buoy tenders in South American waters.

Shipyard Extension, Baltimore, Md.—The Union Shipbuilding Company is rapidly expanding its repair facilities to take care of the increasing Baltimore tonnage. A new marine railway, capable of accommodating vessels up to 10,000 tons deadweight, is being pushed, and will be ready for operation within a few months. Other developments include the doubling of the present machine shop and the erection of overhead crane systems over all ways.

Barge Steamers, Buffalo, N. Y.—The Inland Marine Corporation of Buffalo and New York, will build ten barge steamers of steel, with compound oil burning engines fore and aft, having a capacity of 650 tons each. These barges will not be flat-bottomed boats, but will be slightly rounded with a light keel attached, making them seaworthy in the open waters between New York and Baltimore. Plans for fifty modern barges are also being worked out.

Drydock, Kearney, N. J.—The Federal Shipbuilding Company will construct a floating drydock capable of lifting a 12,000-ton vessel, 425 feet long, to be placed in the fitting-out basin of the company at its plant on the Hackensack River, near the head of Newark Bay. About $1,500,000, including the cost of two tugs and additional plant facilities made necessary by the project. The dock will be built with steel wing walls and wooden pontoons.

Barges, Mobile, Ala.—Two unfinished hulls begun during the war by the Murnan Shipbuilding Company have been bought by the Eastern Transportation Company and will be converted into ocean-going barges. The Murnan plant has also begun work on a $500,000 contract calling for 12 wooden oil barges of 7,500 barrels capacity, and the keel will soon be laid for the steam tug for the same company. The contract specifies that the work shall be done by November 10.

Tanker, San Pedro, Cal.—The Southwestern Shipbuilding Company has a contract to build an 8,500-ton tanker for the Traders Oil Company, to be completed by September 30. The Traders, which is affiliated with the American Fuel Oil Company, 70 Broadway, New York, has seven other tankers running between the Pacific Coast and Europe, has placed orders for twenty additional tankers, and is reported to be in the market for forty others. M. B. McQuigg, is president of the Traders.

Passenger Liners, New York.—The American Line, 9 Broadway, is preparing plans and specifications for the construction of several new passenger liners of intermediate sizes in American shipyards. It is probable that at elast three or four of them will be started before many months have elapsed, and upon completion will ply between New York and Southampton. New vessels will also be constructed and purchased for developing the company's New York and Hamburg service.

Tankers, England.—Contracts have been closed for the construction of eleven large steel tankers to be built by Vickers, Ltd., London, and W. G. Armstrong, Whitworth & Company, Ltd., Newcastle-on-Tyne, for Tankers, Ltd., one of the associated firms of Guret, Jacks & Partners, Inc. The contracts call for the construction of six tankers in one lot and five in another. They will be used for transporting oil from California and other oil centers to Vancouver, B. C. and other Pacific Coast ports, Mexico, South America, Europe and the Orient.

Drydock and Shipbuilding Plant, Philadelphia, Pa.—The Dry Dock & Ship Repairs Corporation of Philadelphia will construct a $5,000,000 drydocking and ship repairing plant at Camden, covering 35 acres of ground having a frontage of 1,020 feet on the Delaware River. Plans call for two drydocks with a lifting capacity of 10,000 and 6,000 tons respectively, a marine railway 3,500 to 4,000 tons capacity, machine shops, derricks for handling hea y metals, floating barges, and all welding shops, plate and angle shops, essentials for a first-class ship repairing plant. Operation will start with a working force of from 1,500 to 2,000 men.

PORT IMPROVEMENTS

Channel, Biloxi, Miss.—The City of Biloxi plans to dredge a 26-foot channel to accommodate dredgewater vessels.

Pile, Breakwater, Ocean City, N. J.—E. A. Corson has contract for a pile breakwater and bulkheads at Fiftieth to Sixtieth Street, Ocean City.

Pier, Philadelphia, Pa.—Department of Wharves, Docks and Ferries, Bourse Building, plans to raze and replace the present pier at Chestnut Street, involving $500,000.

Pier and Shed, Bayonne, N. J.—The Gulf Refining Company, 1 Ingraham Avenue, plans to build a pier and steel shed at East Fifth Street, also stock house. About $73,000 and $28,000, respectively.

Dock, Milwaukee, Wis.—Rockwell Manufacturing Company, 572 Park Street, is receiving bids for 230 foot pile and concrete dock, 3 feet capped piles. F. E. Gray, 86 Michigan Street, architect.

Pier, New York.—The Board of Estimate and Apportionment has adopted a resolution providing for a $1,000,000 pier to replace piers 2 and 3, North River. Murray Hulbert, dock commissioner.

Pier, New York.—Murray Hulbert, commissioner of docks, Pier A, North River, let contract for reconstructing pier and new freight pier at Stanton Street to Lustig & Weil, 103 Park Avenue; $117,074.

Breakwater, Corpus Christi, Tex.—The City of Corpus Christi will have a 5,000-foot breakwater constructed along the waterfront by D. M. Piet & Company, contractors, involving an expenditure of $570,000. John T. Bartlett, secretary.

Terminal Company, Fernandina, Fla.—The Fernandina Wharf & Terminal Company was incorporated with a capital of $60,000. Charles J. Davis is president, Jackson Mizell, vice-president, and Louis S. Chadwick, secretary and treasurer.

Port Improvement, Tokio, Japan.—Viscount Tajiri, Mayor of Tokio, who is now in America, says that Tokio is about to expend $175,000,000 on its port for the accommodation of deep-sea ships. At present no vessel exceeding 200 tons can enter.

Dredger, Mukden.—The American Consul at Mukden reports that tenders are desired for a dredger of the trailing suction type, to cost about £130,000, according to engineer's specifications, for use in connection with the Laio River Conservancy.

Drydock, Cavite, P. I.—The Phillippine Government plans to build a drydock on the Cavite side of Manila Harbor, large enough to accommodate the largest merchant vessels. It is estimated to cost 5,000,000 pesos, of which 1,000.000 pesos are immediately available.

Channels, Memphis, Tenn.—Plans are being prepared by the Morgan Engineering Company, Goodwyn Institute, for thirty-mile cut-off channels, from 10 to 100 feet base, in the Grand River, Mo.; 4,000,000 cubic yards drag-line excavation. J. T. Millbanks, chairman.

Municipal Piers, Philadelphia, Pa.—Construction of three municipal piers on the Delaware River between Market and Appletree Streets has been approved. Carroll R. Thompson, assistant director of Wharves, Docks, and Ferries, estimates cost of property and construction at about $4,000,000.

River Improvement.—Navigation of the Connecticut River from Holyoke, Mass. to Long Island Sound, practically is assured by the signing of the water-power bill by President Wilson, according to Charles H. Tenny, president of the Connecticut River Company, which will build a large dam at Windsor Locks, Conn.

Piers, Portland, Me.—Permission to extend the harbor lines 500 feet at the site of the proposed State pier and the Grand Trunk piers was granted by the War Department to the City of Portland, Maine. The extension will permit the construction of the State pier, 1,000 feet long, also widening of the Grand Trunk piers.

Terminal, Camden, N. J.—The Harbor Commission will call for bids at once for the construction of the proposed marine terminal at Spruce Street. Considerable mechanical equipment will be installed, including loading and unloading machinery, conveying apparatus, etc. The pier will be 102 x 485 feet and the terminal proper 86 x 485 feet. Estimated cost about $400,000.

Steamship Terminal Weehawken, N. J.—The Cunard Terminal Company will shortly erect for the Cunard Line, what is expected to be the largest steamship terminal in the world, along the Hudson River near the West Shore Railroad ferry at Weehawken, following the approval a few days ago by the New Jersey Board of Commerce and Navigation of a grant of 1,100 feet of riparian land, at $50 per foot.

Harbor Dredging, Honolulu, T. H.—The entrance to Honolulu harbor will be deepened to insure the safe entrance of large ships. It will be necessary to dredge the docks between piers 6 and 7 to a depth of thirty-two feet, and the slip between piers 16 and 17 to a depth of thirty-three feet. Plans for the construction of sheds of piers 8, 9, and 10 will have to be hastened to handle the volume of freight and passenger travel. Pier 2 is being rushed to completion.

Coast Harbor Improvement.—A plan to rebuild every harbor and port along the Atlantic coast from Maine to Galveston, and to install new freight-handling machinery to do much of the work now done by men, is suggested in a resolution adopted by the Southwestern Industrial Traffic League, at its meeting in Galveston. This will involve an expenditure of several millions, and introduce machinery and labor-saving devices not now in use, relieving the port congestion caused by strikes.

Graving Dock, Durban.—The site for the new Durban graving dock has been placed at Congella, where a hard bottom was found about 48 feet below the level of low water. The drydock will have the following dimensions: total length from outer caisson, 1,100 feet (divided into two compartments, the outer 660 feet long and inner 440 feet long); width at entrance 110 feet; width at coping, 138 feet 6 inches, width at floor, 110 feet; depth at sill at l.w.s.t., 35 feet; spring tide rise, 6 feet; coping above l.w.s.t., 12 feet; floor of outer end, 40 feet below l.w.s.t.; rise of floor, 1 in 660. Pumping plant is to be provided which will empty the dock in four hours, and the time for filling is 59 minutes. The approach basin is 2,800 feet long, and the proposed width at entrance from the main channel is 1,400 feet long. The construction of the dock was commenced last December and has progressed fairly. The cost of the dock is estimated at £1,300,000.

Drydock, Skinner's Cove, Esquimalt, B. C.—An order in Council was passed by the Dominion Government approving the construction of a drydock estimated to cost about $6,000,000. The proposed dock will have the following dimensions: Length from caisson top to head wall, 1,150 feet; width at entrance, 120 feet; depth on sill at ordinary high water (spring tides), 40 feet; width at coping of dock walls, 144 feet. The structure will be divided into two parts, 650 feet and 500 feet respectively, each part being closed by a steel ship caisson. The dock will be emptied by three centrifugal pumps, each having a capacity of 70,000 gallons per minute. The pumps and other machinery will be operated by a power plant installed on the deck. The walls will be of concrete with granite copings. All keel and bilge blocks will rest on granite strips extending the full length of the dock, and granite will be used for the caisson stops. On the south side of the dock a basin will be formed to allow of repairs, while vessels are afloat and to unload cargoes from vessels before entering the dock. The structure around the basin will be built of reinforced concrete piles.

Harbor Development, Portsmouth, Eng.—The Portsmouth Town Council have decided to purchase a sea frontage at Langston Harbor costing £51,000 for the purpose of establishing a commercial port on that site. Proposed dimensions for the entrance channel are a length of four miles, a bottom width ranging from 600 feet to 700 feet, and a depth of 24 feet at low water springs, which would give a maximum depth at high water springs of 37 feet, 6 inches. Plans for internal work call for a wet dock of 103 acres, the southern portion forming the main basin, and the northern divided into two bays by a central jetty 2,000 feet long. Effective length of wharfage inside the dock would be 13,900 feet, and there would be an additional 7,250 feet at the outside walls. The entrance lock would be 1,000 feet in length, divided into two compartments of 600 feet, and 400 feet respectively. The two tidal quays forming the outside wall would have a depth alongside of 33 feet at low water springs. Under an alternative scheme, three tidal jetties each 3,000 feet in length and 500 feet in width, would be constructed giving a total length of wharfage of 21,400 feet with a depth alongside of 33-feet low water. The cost of the two schemes at prices prevalent immediately before the war is estimated as follows: Entrance channel and training bank £704,000; dock scheme £4,304,000; jetty scheme £4,064,000. This venture is backed by the Portsmouth Corporation.

Government Work

Submarine Base, New London, Conn.—Bureau of Yards and Docks, Navy Department, Washington, D. C., has appropriated $50,000 for the completion of the submarine base at New London.

Power Plant Equipment, Lakehurst, N. J.—The Lord Electric Company, 105 West 40th Street, New York, has contract for furnishing and installing equipment at the naval air station here.

Dredging, Providence, R. I.—United States Engineer let contract for dredging in Housatonic River, Conn., to T. A. Scott Company, Inc., 2929 Pequot Avenue, New London, Conn., $9,600.

Repairing Breakwater, Cleveland, Ohio.—United States Engineer Office, Federal Building, has rejected bids received May 20, for repairing breakwater and placing riprap at Cleveland harbor.

Jetty and Pier Head, Sandusky, O.—United States Engineer Office, Federal Building, Cleveland, let contract for building jetty and pierhead at Sandusky harbor to the Central Dredging Company, Bangor Building, $169,711.

Dredging, Port Gamble, Wash.—U. S. Engineer Office, Burke Building, Seattle, Wash., received only bid for dredging harbor, involving 100,000 cubic yards earth fill, from Puget Sound Bridge & Dredging Co., Central Building, $32,500.

Repairing Piers and Building Superstructure.—United States Engineer Office, 540 Federal Building, Buffalo, N. Y. let contract for repairing and building at Dunkirk harbor to the Empire Engineering Company, North Tonawanda, N. Y.

Marine Railway. Specification 4184.—Bureau of Yards and Docks, Navy Department, Washington, D. C., let contract for elevating and extending marine railway at Naval Air Station to A. M. Hazel, 26 Cortlandt Street, New York, $11,873 (90 days.)

Electric Traveling Cranes.—Specification 4239 Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to build five 40-ton electric traveling cranes for shipbuilding slips at the navy yards at New York, Philadelphia and Norfolk, Va. About $225,000.

Wharf, Boat Basin, Etc., San Diego, Cal—Naval officers have announced that $8,000,000 will be expended at the Naval Air station, North Island, during the next two years. Among the improvements planned are a 100-foot dirigible hangar, concrete wharf and boat basin, concrete launching platforms for seaplanes and a group of barracks and industrial structures.

Harbor Development.—Sealed Proposals, indorsed "Proposals for Harbor Development, Great Lakes, Ill., Specification 4136" will be received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., until 11 o'clock, August 11, 1920, for the construction of breakwaters of three types, rubble mound, rock-filled pile cribs with concrete capping, and sand-filled concrete caisson; the construction of timber pier over existing stone-filled pile and crib breakwater; the construction of timber quay walls; the dredging within the new harbor and the necessary filling with the dredging material behind the quay walls; all at the Naval Training Station, Great Lakes, Ill. Alternative bids will be received for construction of stone-filled timber cribs and sand-filled concrete caissons for certain sections of the breakwater. Drawings and specifications on application to Bureau of Yards and Docks, or to Commandant Naval Training Station, Great Lakes, Ill., $10 deposit, payable to chief of the Bureau of Yards and Docks, required as security for safe return of drawings and specification. C. W. Parks, chief of Bureau.

MARINE SOCIETIES

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
29 West 39th Street, New York.

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